THE HANDBOOK OF RESEARCH IMPACT ASSESSMENT

19950719064

THE HANDBOOK OF RESEARCH IMPACT ASSESSMENT

{SEVENTH EDITION - SUMMER 1997}

DTIC REPORT NUMBER ADA296021

DR. RONALD N. KOSTOFF

OFFICE OF NAVAL RESEARCH

800 N. QUINCY ST.

ARLINGTON, VA 22217

PHONE: 703-696-4198

FAX: 703-696-4274

E-MAIL: KOSTOFR@ONR.NAVY.MIL

AUTHOR IDENTIFICATION

Ronald Neil Kostoff received a Ph. D. in Aerospace and Mechanical Sciences from Princeton University in 1967. At Bell Labs, he performed technical studies in support of the NASA Office of Manned Space Flight, and economic and financial studies in support of AT&T Headquarters. He invented many concepts, including the Orbiting Molecular Shield for high vacuum in low orbit. His initial aerobraking research reported in 1970-71 pioneered the Aeroassisted Orbit Transfer subfield of Orbital Transfer Vehicles. His economic studies resulted in potential savings to the Bell System of over one billion dollars. At the U.S. Department of Energy, he managed the Nuclear Applied Technology Development Division, the Fusion Systems Studies Program, and the Advanced Technology Program. He published numerous papers in the fields of pulsed fusion operation, impact fusion options, and fissile fuel production using advanced breeders. At the Office of Naval Research, he was Director of Technical Assessment for many years. He invented Database Tomography which extracts relational information from large databases. Presently, he manages the Navy Laboratory Independent Research Program. His present interests revolve around improved methods to assess the impact of research, and he has published over 40 papers in this area the last four years.

ABSTRACT

This Handbook describes the practice of Federal research impact assessment (RIA). It describes research impact evaluation for research selection, review, and ex-post assessment. It describes retrospective methods (such as projects Hindsight and TRACES), qualitative methods (such as peer review), and quantitative methods (such as cost-benefit analysis and bibliometrics).

The Handbook is structured as follows. Section I, **Title/ Author/ Abstract/ Background**, contains the rationale for the contents of this Handbook. Section II, **Overview/Executive Summary of Handbook**, describes general problems and promises of RIA, then provides an Executive Summary of the Handbook. Section III, **Introduction**, is the first section of the main body of the Handbook and shows the importance of the topic.

Section IV, **Research Impact Evaluation Techniques**, describes and critiques the different methods used to assess research impact. Section IV-A describes qualitative methods, including peer review problems and principles for quality peer reviews, peer review processes for proposed programs/projects (National Science Foundation, National Institutes of Health, Office of Naval Research, Dutch STW), and peer review processes for existing programs/projects (Department of Energy Office of Basic Energy Sciences, Office of Naval Research, National Institute of Standards and Technology, Army Research Laboratory, Department of Energy National Laboratories). Section IV-B describes semi-quantitative methods, including Project Hindsight, three TRACES studies, and accomplishment books from the Office of Naval Research, Air Force Office of Scientific Research, Department of Energy Office of Health and Environmental Research, Department of Energy High Energy Physics Program, and Advanced Research Projects Agency. Section IV-C describes quantitative methods including bibliometrics, cost-benefit/ economic analyses, cost-efficiency analysis, co-occurrence phenomena, network modeling for direct/ indirect impacts, roadmaps for science and technology evolution, and expert networks.

Section V, **Recommended Areas of Research for RIA**, contains recommended topics to be pursued which would advance RIA. Section VI, **Research Impact Assessment - Summary and Conclusions**, summarizes the results of this Handbook. Section VII, **RIA Options for Research Sponsoring Organizations**, is a self-contained description of the different types of research evaluations recommended for organizations. While the focus is on Federal agencies, the principles and mechanics of implementation are valid for non-Federal organizations as well. Section VIII, **Analysis of RIA Literature**, provides a quantitative and qualitative analysis of the published RIA literature; section IX, **Bibliography**, contains an alphabetically-ordered list of the >400 references that were used for this Handbook; section X, **Suggested Further Reading**, identifies about 3100 papers which provide additional background and context for research evaluation; and section XI, **Most Highly Cited Papers**, contains a list of the 450 most highly cited papers in RIA.

TABLE OF CONTENTS

I. BACKGROUND

In research sponsoring organizations, the selection and continuation of research programs must be made on the basis of outstanding science and potential contribution to the organization's mission. There have been increasing pressures to link science and technology programs and goals even more closely and clearly to organizational as well as broader societal goals. This is reflected in a number of studies [Brown, 1992; NAS, 1992; Carnegie, 1992], in the controversial National Institutes of Health strategic planning process, in the controversial statements by the previous National Science Foundation director about closer alignment with industry and other government agencies, and in conversations with numerous government officials.

In tandem with the pressures for more strategic research goals are motivations to increase research assessments and reporting requirements to insure that the increasingly strategic research goals are being pursued by proposed and existing research programs. The 1992 Congressional Task Force report on the health of research [Brown, 1992] stated, as one of its two recommendations: "Integrate performance assessment mechanisms into the research process using legislative mandates and other measures, to help measure the effectiveness of Federally funded research programs".

The Government Results and Performance Act of 1993 (Public Law 103-62) was passed on August 3, 1993. This Act provides for the establishment of strategic planning and performance measurement in the Federal government, and for other purposes. Not only will the Federal agencies be required to establish performance goals for program activities, but as the law states, they will be required to establish performance indicators to be used in measuring or assessing the relevant outputs, service levels, and outcomes of each program activity.

A pilot program was established to identify appropriate measures and procedures that could be applied to different agencies and different types of programs, and would satisfy the GPRA requirements. Some strengths and weaknesses of the process as applied to R&D have surfaced already [Brown, 1996]. A recent paper in Science [Kostoff, 1997h] identified potential problems for basic research if the GPRA metrics are used as the main performance indicators. This paper proposed an alternate approach for evaluating the progress and performance of basic research.

Due to increased world competition, and the trends toward corporate downsizing, parallel pressures exist for industrial research organizations to link research programs more closely with strategic corporate goals and to increase research performance and productivity. In tandem with the increasing governmental interests in research assessment stated above, there is considerable industrial interest in research assessment as well. As an example, the Industrial Research Institute (IRI), whose 260 member companies invest over $55 billion annually in R&D, has shown intense interest in measuring research performance and effectiveness. The IRI has commissioned one of its internal panels (headed by Dr. James W.

Tipping) to research the field and write a position paper on measuring and improving effectiveness of R&D on company performance. According to Dr. Tipping, two roundtables on this subject have been held. They have been oversubscribed but limited to 50 companies [Tipping, 1993].

When the above activities are integrated and placed into a mosaic, the inescapeable trend for the future becomes clear. The research sponsoring agencies will become more accountable to the Administration and Congress on the relationship between sponsored programs and strategic goals, and soon thereafter the research performers will become more accountable to the sponsoring agencies. In addition, the accountability of industrial research to the broader corporate goals will increase (as has been observed over the past decade), and improved methods of measuring research performance and productivity will be sought continually by industrial research organizations. It is important that research managers and administrators in government, industry, and academia understand the assessment approaches which could be utilized to evaluate research quality and goal relevance, and that researchers gain an understanding of these evaluation approaches as well.

In the Congressional Task Force report on the health of research [Brown, 1992] mentioned above, the authors recognized the difficulty of integrating performance assessment mechanisms into the research process. In addressing the difficulty of implementing this recommendation, the report stated further: "More daunting than political resistance to performance assessment are the technical obstacles. Because policy-oriented assessment has not been a part of the research process in the past, its implementation must be both gradual and flexible. There are some initial efforts underway". The reference in the Task Force report for these 'initial efforts' [Kostoff, 1992a] is the text of a presentation by the author at the Third International Conference on Management of Technology.

The present Handbook integrates and updates the results from Kostoff [1992a] and subsequent studies [Kostoff, 1992d, 1993a-g, 1994a-l, 1995a-e, 1996a-c, 1997a-q; Odeyale and Kostoff, 1994a-c; Zurcher and Kostoff, 1997] concerned with research impact assessment (RIA). The front part starts by identifying the many facets of research impact, then focuses on strengths and weaknesses of selected major techniques used in practice by the Federal government to assess research impact. It ends by identifying promising research opportunities for advancing the field of RIA.

II. OVERVIEW/EXECUTIVE SUMMARY OF HANDBOOK

OVERVIEW

UNDERUTILIZATION OF RIA

Research, the pursuit and production of knowledge, has become a substantial investment in the U. S. and the rest of the developed world today. Depending on what is defined specifically as research

in practice, public and private investment in research in the U. S. alone amounts to tens of billions of dollars per year. In 1990, for example, Federal support for basic and applied research approximated $22B, about 47 percent of total support for research in the U.S. [OTA, 1991]. Typically, with investments of this magnitude, project selection and management are performed using the latest techniques available. Project payoff is estimated using the latest techniques and algorithms available. In addition, assessments of a large magnitude investment are done on a continuing basis, and there is a continual feedback loop to assure the investment will achieve its goals and targets.

While the methods used in the performance of research continually advance the state-of-the-art, the methods used for its identification and selection have changed little in decades. In evaluation and assessment of existing and completed research, not only have the methods in practice changed little with time, but the numbers of organizations which use any but the most rudimentary methods also remain a handful. While the scientific and social science literatures abound with advanced methodologies for identifying and selecting new research, managing existing research, and evaluating and assessing research retrospectively, the implementation of these methods by the research sponsoring community remains minimal.

REASONS FOR UNDERUTILIZATION OF RIA

The reasons for reluctance to implement RIA vary [Kostoff, 1994f]. The rewards in research and research management go to new discoveries, not for quality assessments. Neither the costs nor time requirements of RIA are negligible, and have to be weighed against additional research which could be performed. More immediate organizational requirements are assigned higher priority than RIA. For example, an OTA assessment of the defense technology base states: "OSD [Office of the Secretary of Defense-RNK] personnel spend a large part of their time defending technology base programs or answering congressional mail, leaving little time available to evaluate technology base programs" [OTA, 1989].

The RIA outcomes are not always predictable or positive from a micro viewpoint, and 'pet' projects may be terminated after a rigorous evaluation. Any negative results from an RIA may provide executive or legislative branch overseers, or corporate management, ammunition for budget reductions. Finally, since there is very little experience with use of advanced evaluation techniques, there is insufficient evidence at present that use of advanced evaluation techniques will result in better payoff than use of rudimentary techniques. To many research managers and administrators, there is little to be gained from RIA, and a potential for loss.

BENEFITS OF INCREASED UTILIZATION OF RIA

However, with the ascendency of Total Quality Management in many organizations, and with decreasing budgets and increased

competitiveness at many levels, the motivation for a better understanding of the quantitative and qualitative measures of research impact has escalated in importance. Motivation to incorporate RIA into a permanent component of an organization's mode of operation, and determination to use the latest technological advances consistent with an organization's RIA requirement could have significant consequences at the organizational and national levels.

One major benefit would be to improve organizational efficiency. A properly executed RIA would target the people and the exogenous variables (management climate, funding conditions, infrastructure, etc.) necessary to increase research output relevant to the organization's goals. An RIA which increased communication among the researchers and potential research customers during the conduct of research would allow a smoother conversion of the products of research to technology through better integration of the users with the research performers.

Another major benefit would be to identify the diverse impacts of basic research. The impacts of basic research are pervasive throughout a technological society, but for the most part the impacts of basic research are indirect on technologies, systems, and end products. A major limitation of articulating the benefits of basic research has been the lack of data which could show the pathways and linkages through which the research impacts the intermediate or end products. A credible RIA of completed research would trace the dissemination of the research products through the many communication channels and would identify the multitude of near and long term research impacts (impact on other research fields, impact on technology, impact on systems, impact on education, etc.). Having this data would provide more substantive arguments for continuing to provide the necessary funds to those who control the allocation of research funds.

RECENT RIA STUDIES

One objective of the author's recent studies and the present Handbook is to identify many of the advanced and credible RIA approaches in use, or available today, and to enumerate both their strengths and weaknesses. Since research impact has many facets, its assessment must use as many methods and as many types of experts as required to address as many of these components as possible. Credible assessments will then weight the results of the different facet assessments relative to the different organizational goals, and arrive at conclusions optimal to the organization's interests.

Combinations of RIA approaches are recommended when performing a full assessment. While the readers schooled in systems reliability may question how the results from multiple imperfect approaches are improved as the number of approaches increase, experience has shown that a more acceptable product does result when different approaches are used. The effect appears to be additive rather than multiplicative. When different RIA approaches

result in similar findings, the user will have confidence in the general theme of the results. When different approaches produce conflicting results, much value and understanding is gained by trying to understand the causes of the differences and trying to then resolve these differences.

Another objective of the recent studies and this Handbook is to show, somewhat indirectly, that while there is a significant gap between the RIA methods available in the literature and the RIA methods actually in use, there is also a substantial gap between the technologies becoming available from the research laboratories (such as information management and processing) and the technologies employed in the published methods. In the U. S., Federal support for developing the assessment methodologies which use the latest technologies has lagged other parts of the world. A cursory reading of the relevant literature shows that in the past two decades the U.S. efforts in this field have advanced at a very slow pace, and in many subfields <u>the U. S. has been surpassed by other nations, notably those of Western Europe</u>. If it is assumed that improved RIA will lead to a more efficient allocation of research resources, then in the highly competitive research and technology based world which has evolved, the U. S. cannot afford to continue business as usual in its treatment of research and its impacts. It is hoped that this Handbook will help spur the Federal government, and private sources as well, to focus a concerted effort in advancing the techniques and implementation of RIA.

The first part of this Handbook is divided into three segments, which range from qualitative to quantitative approaches. The first segment deals with qualitative approaches to RIA. Foremost among these are variants on the common theme of peer review. While peer review (evaluation of research and its consequences by 'peers', or experts on the different facets of research and its impacts) is the method used most widely to evaluate research, it has its detractors, as will be shown in this Handbook. Because of cost and subjectivity, other methods to complement or replace peer review, and which are perhaps less costly and more objective, are being actively pursued.

The second segment deals with semi-quantitative approaches. These methods make little use of mathematical tools but attempt to draw on documented approaches and results wherever possible. They have limited credibility in the analytic community, since the selection of innovations to be analyzed tends to be arbitrary rather than mathematically rigorous, and they are viewed more as anecdotal approaches than serious technical approaches. Nevertheless, in practice, some of these approaches (namely, studies of accomplishments resulting from sponsored research programs, or studies of systems and the research products which were eventually converted and incorporated into those systems) are widely used by the research sponsoring organizations.

The third segment deals with the quantitative and fiscal approaches to RIA. These approaches make heavy use of mathematical and analytic tools, and utilize computer capabilities extensively. Probably the heaviest concentration of literature papers today are

in this category. It should be noted that there are hybrid techniques which span more than one of the three categories. For example, a retrospective study of significant events in cancer research [Narin, 1989] included a bibliometric component (citation and co-citation analyses).

EXECUTIVE SUMMARY

GENERAL PRINCIPLES AND CONCLUSIONS

There are some general principles, findings, and conclusions when the different methods described in this Handbook and their results are integrated and interpreted. First and foremost is **the role of motivation and associated incentives.** The research managers and administrators, and those with responsibility for higher level oversight, have to be convinced of the value of RIA to their organizations for the improved allocation of research resources. More important than any evaluation criteria selected is the dedication of an organization's management to the highest quality objective review, and the associated emplacement of rewards and incentives to encourage quality reviews. The team assigned responsibility to carry out RIA must be motivated to generate the highest quality product, not just 'answer the mail', as is done in many organizations today. This means selecting the best suite of methods available to accomplish organizational objectives, and selecting the most competent and objective individuals to participate in the RIA. The RIA managers must be motivated to examine the impact from as many perspectives as possible, to gain the most complete understanding. Finally, the objectives, importance, and benefits of RIA must be articulated and communicated to the researchers and research managers at the initiation of RIA, so that the reviewees will participate in the RIA as fully and as cooperatively as possible.

The total R&D process in an organization should be designed to include RIA as an **integral component**, not as an afterthought or an add-on. This will allow an orderly and continuous monitoring of the full research selection, review, and post-mortem analysis process, and insure that the best research consistent with the organization's goals is being funded. The evaluation methods selected should not be overly complex or require massive permanent staffs, and should offer minimum interference in the performance of the research [Robb, 1994]. Most managers regard applying overly elaborate and rigorous-seeming techniques to industrial R&D as inappropriate [Nelson, 1994]. A reasonable fraction of the R&D budget should be allocated for RIA purposes, and advancement along a career path for RIA professionals should parallel that of the research performers.

An RIA should be conducted with maximum access to, and awareness of, information about research and technology development being pursued throughout the world. Access of the RIA to existing technology information would also be useful. This information will help determine whether the research being assessed is breaking new

ground and, for high-tech organizations, whether the research being assessed is improving existing or developing technology.

Optimally, a database which contains this information would be available to those conducting an RIA. Over the past five years, substantial progress has been made in developing a database of federally-sponsored science and technology development. In 1991, the author developed a Federal multiagency funded research programs database which contained narrative descriptions of 90,000 projects. Over the past two years, the RADIUS database has been developed by RAND-CTI. This database contains narrative descriptions of over 200,000 projects, and describes federal agency S&T at five different hierarchical levels. However, a comprehensive research and (developing and existing) technology database that incorporates government and industry programs, both domestic and foreign, remains to be developed. Construction of such a database would require cooperation among Federal research sponsoring agencies and private organizations, domestic and foreign, at a minimum.

For organizations which sponsor substantial basic research, the RIA should be structured to identify impacts which occur **many decades after the research is performed.** The reasons for this are twofold. First, the impacts of basic research on organizational missions such as systems and operations can take decades before they are realized. Second, these organizational mission impacts will provide data for predictive models that relate research evaluation results to organizational mission impacts. Also, the **indirect impacts** of the research must receive a proper accounting. These indirect impacts contribute to an ever expanding pool of knowledge, and it is the **level of this pool which serves as the critical path to limiting the rate of advance of mission-oriented research**, and thereby technology and systems growth. While the determination of indirect impacts is complex and data intensive, it is absolutely necessary for a credible RIA.

The present Handbook addresses the predictive reliability of the RIA processes very briefly, mainly because there is little literature which provides the basis for predicting which research programs/proposals will have the desired downstream impact. For example, the relationship between a proposal's peer review score or a project's bibliometric rating and the downstream impact on an organization's mission is not addressed in published studies, although some initial efforts have been initiated [Van den Beemt, 1991]. One could raise the question, as many active researchers have, as to whether there is value to any of these assessment techniques, since their predictive value is unknown. The credibility and predictability of these assessment techniques are ripe topics for research. A long term tracking system for research product evolution would be required to gather the necessary data. The system would require agreement and coordination from a number of the larger Federal research sponsoring agencies, and maybe from industrial organizations as well. While such a system would not provide absolute answers, since tracking of the informal modes of knowledge communication would be almost impossible, it would provide a much better picture of research impact and its

predictability than exists now. With the present state of information storage and processing capabilities, **research product evolution tracking is an idea whose time has come.**

PEER REVIEW SUMMARY

Peer review of research represents evaluation by experts in the field, and is the method of choice in practice in the U. S. [Salasin, 1980; Logsdon, 1985; Chubin, 1990, 1994; Kostoff, 1993b]. Its objectives range from being an efficient resource allocation mechanism to a credible predictor of research impact.

Requirements for High Quality Peer Review

Many studies related to peer review have been reported in the literature, ranging from the mechanics of conducting a peer review, to examples of peer reviews, to detailed critiques of peer reviews and the process itself (e.g., Barker [1992], Chubin [1990, 1994], Cicchetti [1991], Cole [1978, 1981a, 1981b], Cozzens [1987], DOD [1987], DOE [1982, 1993], Frazier [1987], Kostoff, [1988], Logsdon, [1985]; Ormala, [1989]; OTA, [1986]; Salasin, [1980], and Nicholson [1987]). A non-standard peer review approach for concept comparisons is the Science Court. As in a legal procedure, it has well defined advocates, critics, a jury, etc. It was applied by the author to a review of alternate fusion concepts in 1977 [DOE, 1978]. This procedure had substantial debate and surfacing of crucial issues, but it was time-consuming compared to a standard panel assessment.

While these reported studies present the process mechanics, the procedures followed, and the review results, the reader cannot ascertain the quality of the review and the results. In practice, procedure and process quality are mildly necessary, but nowhere sufficient, conditions for generating a high quality peer review. Many useful peer reviews have been conducted using a broad variety of processes, and while well documented modern processes (e.g., DOE [1993]) may contribute to the efficiency of conducting a review, more than process is needed for high quality. There are many intangible factors that enter into a high quality review, and before examples of reviews are presented in the main body of this Handbook, some of the more important factors will be discussed.

The desirable characteristics of a peer review can be summarized as [Chubin, 1994]:

1. an effective resource allocation mechanism;
2. an efficient resource allocator;
3. a promoter of science accountability;
4. a mechanism for policymakers to direct scientific effort;
5. a rational process;
6. a fair process;
7. a valid and reliable measure of scientific performance.

High quality peer reviews require as a minimum the conditions summarized from Ormala [1989]:

1. The method, organization and criteria for an evaluation should be chosen and adjusted to the particular evaluation situation;

2. Different levels of evaluation require different evaluation methods;

3. Program and project goals are important considerations when an evaluation study is carried out;

4. The basic motive behind an evaluation and the relationships between an evaluation and decision making should be openly communicated to all the parties involved;

5. The aims of an evaluation should be explicitly formulated;

6. The credibility of an evaluation should always be carefully established;

7. The prerequisites for the effective utilization of evaluation results should be taken into consideration in evaluation design.

Assuming these considerations have been taken into account, **three of the most important intangible factors for a successful peer review are: Motivation, Competence, and Independence.** The review leader's motivation to conduct a technically credible review is the cornerstone of a successful review. The leader selects the reviewers, summarizes their comments, guides the questions and discussions in a panel review, and makes recommendations about whether the proposal should be funded. The quality of a review will never go beyond the competence of the reviewers. Two dimensions of competence which should be considered for a research review are the individual reviewer's technical competence for the subject area, and the competence of the review group as a body to cover the different facets of research issues (other research impacts, technology and mission considerations and impacts, infrastructure, political and social impacts). The quality of a review is limited by the biases and conflicts of the reviewers. The biases and conflicts of the reviewers selected should be known to the leader and to each other.

A broad range of reviewer expertise enhances the review results substantially. A key component of the process reported in Kostoff [1988] was the use of mixed levels of reviewers on the panels to evaluate the different potential impacts of research. The panels included:

1. bench-level researchers to address the impact of the proposed research on its field;

2. broad research managers to address potential impact on allied research fields;

3. technologists to address potential impact on technology and the potential of the research to transition to higher levels of development;

4. systems specialists to address potential impact on systems and hardware;

5. operational naval officers to address the potential impact on naval operations.

The presence of reviewers with different research target perspectives and levels of understanding on one panel provided a depth and breadth of comprehension of the different facets of the research impact that could not be achieved by segregating the science and utility components into separate panels and discussions.

Nearer-term research impacts typically play a more important role in the review outcome than longer-term impacts, but do not have quite the importance of team quality, research approach, or the research merit. A minimal set of review criteria should include team quality, research merit, research approach, productivity, and mission relevance.

The best features of different organizations' peer review practices can be combined into a heuristic protocol for the conduct of successful peer review research evaluations and impact assessments. The main aims of the protocol are to insure that the final assessment product has the highest intrinsic quality and that the assessment process and product are perceived as having the highest possible credibility. The protocol elements are:

PEER REVIEW RESEARCH EVALUATIONS

1. The objectives of the assessment must be stated clearly and unambiguously at the initiation of the assessment by the highest levels of management, and the full support of top management must be given to the assessment. In turn, the objectives, importance, and urgency of the assessment must be articulated and communicated down the management hierarchy to the managers and performers whose research is to be assessed, and the cooperation of these reviewees must be enlisted at the earliest stages of the assessment;

2. The final assessment product, the audience for the product, and the use to be made of the product by the audience should be considered carefully in the design of the assessment;

3. One person should be assigned to manage the assessment at the earliest stage, and this person should be given full authority and responsibility for the assessment;

4. The assessment manager should report to the highest organizational level possible in order to insure maximum independence from the research units being assessed;

5. The reviewers should be selected to represent a wide variety of viewpoints, in order to address the many different facets of research and its impact [Kostoff, 1988]. These would include bench-level researchers to address the impact of the proposed research on the field itself; broad research managers to address potential impact on allied research fields; technologists to address potential impact on technology and the potential of the research to transition to higher levels of development; systems specialists to address potential impact on systems and hardware; and operational personnel to address the potential impact on downstream organizational operations. The reviewers should be independent of the research units being evaluated, and independent of the assessing organization where possible. The objectives of,

and constraints on (if any), the assessment should be communicated to the reviewers at the initial contact;

6. Maximum background material describing the research to be assessed, related research and technology development sponsored by external organizations, the organization structure, and other factors pertinent to the assessment, should be provided to the reviewers as early as possible before the review. This will allow the reviewers and presenters to use their time most productively during the review;

7. Recommendations resulting from the assessment should be tracked to insure that they are considered and implemented, where appropriate. For research programs, planning, execution, and review are linked intimately. Feedback from the review outcomes to planning for the next cycle should be tracked to insure that the review/planning coupling is operable.

LEVELS OF ORGANIZATIONAL RESEARCH EVALUATION

1. Evaluations should be performed at three levels of resolution in the organization.

1a. The highest level would be an annual corporate level review of how the organization performs research. If the organization has a separate research unit, then the unit should be evaluated as an integrated whole. If research is vertically integrated with development, then the research should preferably be evaluated as part of a total organization R&D review. The charter of this highest level assessment would be to review, at the corporate level, general policy, organization, budget, and programs (e.g., NIST, [1991]). Total inputs and outputs, including integrated bibliometric indicators, would be examined. Overall research management processes would be examined, such as selection, execution, review, and technology transfer of research. The overall investment strategy would be evaluated, and would include different perspectives of the program, such as technical discipline, performer, and end use allocation. The integration of the research objectives with the larger organization objectives would be assessed. The evaluators would include, but not be limited to, representatives of the stakeholder, customer, and user community whose potential conflicts with the organization are minimal.

1b. The second level would be trienniel peer review of a discipline or management unit at the program level (e.g., Kostoff, [1988, 1994b]), where a program is defined as an aggregation of work units (Principal Investigators). If the organization has a separate research unit, then the discipline should be evaluated as an integrated whole. In the nominal review, quality and relevance could be evaluated concurrently. If research is vertically integrated with development, then the research should preferably be evaluated as part of a total vertical structure R&D review. In the nominal vertical structure review, quality and relevance should preferably be evaluated separately. Thus, research evaluation must take into account how research is structured, integrated, and

managed within an organization. Research quality criteria should include research merit, research approach, productivity, and team quality. Relevance criteria should include short term impact (transitions and/or utility), long term potential impact, and some estimate of the probability of success of attaining each type of impact. While the emphasis is on peer review, bibliometric and other type of indicators should be utilized to supplement the peer evaluation.

1c. The third level would be a minimum of trienniel peer review at the work unit (Principal Investigator) level (e.g., DOE, [1993]). Most of the program level issues described above are applicable and need not be repeated here.

1d. For each of these three levels of review, the following criteria and issues should be considered during the review as appropriate.

1e. <u>CRITERIA TO BE CONSIDERED</u>

1ei. Quality and uniqueness of the work

1eii. Scientific and technological opportunities in areas of likely organization mission importance

1eiii. Need to establish a balance between revolutionary and evolutionary work

1eiv. Position of the work relative to the forefront of other efforts

1ev. Responsiveness to present and future organization mission requirements

1evi. Possibilities of follow-on programs in higher R&D categories

1evii. Appropriateness of the efforts for organization vice other organizations

1eviii. Other organization connection (coordination) of the work

1f. <u>QUESTIONS TO BE ASKED OF ORGANIZATION PROGRAMS</u>

1fi. What is the investment strategy of the larger management unit. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. For each program being reviewed, what is the investment strategy for its thrust areas.

1fii. What are we trying to do (in a systems concept)?

1fiii. Can specific advantage to the organization be identified if program is successful?

1fiv. How is the system done today and what are the limitations of the current practice?

1fv. Would the work be supported if it were not already underway?

1fvi. Assuming success, what difference does it make to the user in a mission area content?

1fvii. What is the technical content of the program and how does it fit with other ongoing efforts in academia, industry,

organization labs, other labs, etc.?

1fviii. What are the decision milestones of the program?

1fix. How long will the program take; how much will the program cost; what are the mid-term and final objectives of the program?

In Europe, another development line has been to commission evaluation experts either to support panels or to conduct independent assessments which may involve surveys, in-depth interviews, case studies, etc [Ormala, 1994]. Barker [1992] describes how evaluation experts coming from two main communities (civil servants and academic policy researchers) interact in evaluation of R&D in the UK. The performance of evaluations, including the synthesis of evidence and the production of conclusions and recommendations, is done by professionals, as opposed to panels of eminent persons.

<u>Problems with Peer Review</u>

Peer review problems include [Roy, 1985; King, 1987; Kruytbosch, 1989; Chubin, 1990, 1994;]:

1. Partiality of peers to impact the outcome for non-technical reasons;
2. an 'Old Boy' network to protect established fields;
3. a 'Halo' effect for higher likelihood of funding for more visible scientists/ departments/ institutions;
4. reviewers differ in criteria to assess and interpret;
5. the peer review process assumes agreement about what good research is, and what are promising opportunities.

These potential problems should be considered during the process of selecting research impact assessment approaches.

Another problem with peer review is cost. The true **total** costs of peer review can be considerable but tend to be ignored or understated in most reported cases. For serious panel-type peer reviews, where sufficient expertise is represented on the panels, <u>total real costs will dominate direct costs</u> by as much as an order of magnitude or more [Kostoff, 1994e]. The major contributor to total costs for either type of review is the time of all the players involved in executing the review. With high quality performers and reviewers, time costs are high, and the total review costs can be a non-negligible fraction of total program costs, especially for programs that are people intensive rather than hardware intensive.

The issue of peer review predictability affects the credibility of technological forecasting directly. A few studies have been done relating reviewers' scores on component evaluation criteria to proposal or project review outcomes. Some studies have been done in which reviewers' ratings of research papers have been compared to the numbers of citations received by these papers over time [Bornstein, 1991a, 1991b]. Correlations between reviewers' estimates of manuscript quality and impact and the number of

citations received by the paper over time were relatively low. The author is not aware of reported studies, singly or in tandem, that have related peer review scores/rankings of proposals to downstream impacts of the research on technology, systems, and operations, although some initial efforts have been initiated [Van den Beemt, 1991]. This type of study would require an elaborate data tracking system over lengthy time periods which does not exist today. Thus, the value of peer review as a predictive tool for assessing the impact of research on an organization's mission (other than research for its own sake) rests on faith more than on hard documented evidence.

PEER REVIEW CONCLUSIONS

Peer review is the most widely used and generally credible method used to assess the impact of research. Much of the criticism of peer review has arisen from misunderstandings of its accuracy resolution as a measuring instrument. While a peer review can gain consensus on the projects and proposals that are either outstanding or poor, there will be differences of opinion on the projects and proposals that cover the much wider middle range. For projects or proposals in this middle range, their fate is somewhat more sensitive to the reviewers selected. If a key purpose of a peer review is to insure that the outstanding projects and proposals are funded or continued, and the poor projects are either terminated or modified strongly, then the capabilities of the peer review instrument are well matched to its requirements.

However, the value of peer review as a predictive tool for assessing the impact of research on an organization's mission (other than research for its own sake) rests on faith more than on hard documented evidence. Also, for serious panel-type peer reviews or mail-type peer reviews, where sufficient expertise is represented on the panels, total real costs will dominate direct costs. The major contributor to total costs is the time of all the players involved in executing the review. With high quality performers and reviewers, time costs are high, and the total review costs can be a non-negligible fraction of total program costs, especially for programs that are people intensive rather than hardware intensive.

Most methods used in practice include criteria which address the impact of research on its own and allied fields, as well as on the mission of the sponsoring organization. Nearer-term research impacts typically play a more important role in the review outcome than longer-term impacts, but do not have quite the importance of team quality, research approach, or the research merit. A minimal set of review criteria should include team quality, research merit, research approach, research productivity, and a criterion related to longer-term relevance to the organization's mission. More important than the criteria is the dedication of an organization's management to the highest quality objective review, and the associated emplacement of rewards and incentives to encourage quality reviews.

SEMI-QUANTITATIVE METHODS SUMMARY

In the evaluation of research performance and impact, a spectrum of approaches may be considered. At one end of the spectrum are the subjective, essentially non-quantitative approaches, of which peer review is the prototype [Chubin, 1994]. At the other end of the spectrum are the mainly quantitative approaches, such as evaluative bibliometrics and cost-benefit [Narin, 1994; Mansfield, 1991]. In between are retrospective or case study approaches [Kostoff, 1993d; Kingsley, 1993].

These retrospective methods make little use of mathematical tools, but draw on documented approaches and results wherever possible. In practice, there are two major reasons that research sponsoring organizations perform retrospective studies of research. Positive research impact on the organization's mission provides evidence to the stakeholders that there is benefit in continuing sponsorship of research. Also, if the study is sufficiently comprehensive, the environmental parameters which helped the research succeed can be identified, and these lessons can be used to improve future research.

There are two major variants of retrospective studies. One type starts with a successful technology or system and works backwards to identify the critical R&D events which led to the end product. The other type starts with initial research grants and traces evolution forward to identify impacts. The tracing backwards approach is favored for two reasons: 1) the data is easier to obtain, since forward tracking is essentially non-existent for evolving research; and 2) the sponsors have little interest in examining research that may have gone nowhere.

While methods for performing retrospective and case studies may differ within and across industry and government [Kingsley, 1993], especially concerning the research question, case selection, and analytic framework, the fundamental evaluation problems encountered are pervasive across these different methods. Now, a few of the more widely known case studies will be reviewed, and the key pervasive problems and findings will be identified. These retrospective studies include Project Hindsight, Project TRACES and its follow-on studies, and Accomplishments of Department of Energy (DOE) Office of Health and Environmental Research (OHER) and of the Advanced Research Projects Agency (ARPA).

SPECIFIC RETROSPECTIVE STUDIES

Project Hindsight

Project Hindsight was a retrospective study performed by the Defense Department in the mid-1960s to identify those management factors important in assuring that research and technology programs are productive and that program results are used [DOD, 1969]. The evolution of the new technology represented in each of the 20 weapons systems selected was traced back in post-WW2 time to critical points called "Research or Exploratory Development (RXD) Events".

Original TRACES Study

In 1967, The National Science Foundation (NSF) instituted a study [IITRI, 1968] to trace retrospectively key events which had led to a number of major technological innovations. One goal was to provide more specific information on the role of the various mechanisms, institutions, and types of R&D activity required for successful technological innovation. Similar to Project Hindsight, key 'events' in the R&D history of each innovation selected were identified, and their characteristics were examined.

Follow-On TRACES Study

In a follow-on study to TRACES, the NSF sponsored Battelle-Columbus Laboratories to perform a case study examination of the process and mechanism of technological innovation [Battelle, 1973]. For each of the ten innovations studied, the significant events (important activity in the history of an innovation) and decisive events (a significant event which provides a major and essential impetus to the innovation) which contributed to the innovation were identified. The influence of various exogenous factors on the decisive events was determined, and several important characteristics of the innovative process as a whole were obtained. The following important exogenous factors for producing significant innovations were identified:

1. The technical entrepreneur (a major driving force in the innovative process);
2. Early recognition of the need;
3. Government funding (more generally, availability of financial support, from whatever source);
4. The occurrence of an unplanned confluence of technology (confluence of technology occurred for some innovations as a result of deliberate planning, rather than by accident);
5. Most of the innovations originated outside the organization that developed them;
6. Additional supporting inventions were required during the development effort for all the innovations studied to arrive at a product with consumer acceptance.

While the technical entrepreneur is viewed as extremely important to the innovative process, it does not appear (to the author) to be the critical path factor. Examination of the historiographic tracings which display the significant events chronologically for each of the innovations shows that <u>an advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur. The entrepreneur can be viewed as an individual or group with the ability to assimilate this diverse information and exploit it for further development. However, once this pool of knowledge exists, there are many persons or groups with capability to exploit the information, and thus the real critical path to the innovation is more likely the knowledge pool than any particular entrepreneur.</u> The entrepreneurs listed in the study undoubtedly accelerated the introduction of the

innovation, but they were at all times paced by the developmental level of the knowledge pool.

Recent TRACES Study

In a modern version of the TRACES study, the National Cancer Institute initiated an assessment [Narin, 1989] to determine whether there were certain research settings or support mechanisms which were more effective in bringing about important advances in cancer research. The approach taken was analogous in concept to the initial TRACES study, with the addition of citation analyses to provide an independent measure of the impact of the Trace papers (papers associated with each key 'event'), and by adding control sets of papers.

DARPA Accomplishments Study

The Institute for Defense Analysis produced a document [IDA, 1991] describing the accomplishments of the Defense Advanced Research Projects Agency (DARPA-now renamed ARPA). Of the hundreds of projects and programs funded by DARPA over its then (1988) 30 year lifetime, 49 were selected and studied in detail, and conditions for success were identified.

The qualities of DARPA-supported programs and projects that contributed to success can be summarized:

1. A need existed for what the output could do;
2. There was a strong commitment by individuals to a concept;
3. Bright and imaginative individuals were given the opportunity to pursue ideas with minimal bureaucratic encumbrance;
4. There was an ongoing stream of technical developments and evolution;
5. DARPA management gave strong, top-level management support;
6. There was explicit effort, taken early, to improve acceptance by the user community.

DOE OHER Accomplishments Book

The approach taken by DOE was to describe the 40-year history of OHER [DOE, 1983, 1986], and present selected accomplishments in different research areas from different points in time. This technique allowed impacts and benefits of the research to be tracked through time, and in some cases to be quantified as well.

PRINCIPLES OF HIGH QUALITY RETROSPECTIVE STUDIES

A careful reading of the above, and many other, retrospective studies shows that it is difficult to assess study quality on the sole basis of the published report. However, principles for high quality retrospective studies have been generated by the author by integrating the contents of these reports with personal experience in conducting retrospective studies. A high quality retrospective study is an accurate reflection of the evolution and relation of all critical sciences and technologies which resulted in the technology of present interest. Thus, a high quality retrospective

study is analogous to a high resolution picture of the evolving relationships among science and technology areas related critically to the focal technology, and incorporates especially the concepts of awareness, coordination, and completeness. More specific requirements, or underlying principles, necessary for a high quality retrospective study can be formulated as follows.

The most important factor is the commitment of the retrospective study organization's senior management to high-quality retrospective studies, and the associated emplacement of rewards and incentives to encourage such retrospective studies.

The second most important factor is the retrospective study manager's motivation to construct a technically credible and visionary retrospective study. The retrospective study manager sets the boundary conditions and constraints on the retrospective study scope, structures the working groups, and selects the final retrospective study elements from a myriad of inputs. In some organizations, the retrospective study manager has the latitude to select the complete retrospective study process and criteria, and in all organizations presently has the latitude to select the retrospective study contributing technical experts by a non-random process. If the retrospective study manager does not follow, either consciously or subconsciously, the highest standards in selecting these experts, the retrospective study's final form could be substantially determined even before the study process begins.

The third most important factor consists of the study experts' competence and objectivity. Each expert should be technically competent in his subject area, and the competence of the total retrospective study development team should cover the multiple research and technology areas critically related to the science or technology area of present interest. In addition, the team's focus should not be limited to disciplines related only to the focal technology area (which tends to reinforce the status quo and further promulgate development along very narrow lines), but should be broadened to disciplines and technologies well beyond the focal technology.

For retrospective studies which will be used as a basis for comparison of science and technology programs or projects, the fourth most important factor is normalization and standardization across different retrospective studies, study component teams, and science and technology areas. For science and technology areas which have some similarity, use of common experts (on the study teams) with broad backgrounds which overlap the disciplines can provide some degree of standardization. For very disparate science and technology areas, some allowances need to be made for the relative strategic value of each discipline to the organization, and arbitrary corrections applied for benefit estimation differences and biases. Even in this case of disparate disciplines, some normalization is possible by having some common team members with broad backgrounds contributing to the retrospective studies for diverse programs and projects.

The fifth most important factor is criteria for retrospective

study component selection. Since retrospective studies tend to focus on the critical science and technology events which led to successful technologies/ systems, the definition of criteria for 'successful' and 'critical' is of utmost importance for establishing the credibility of the retrospective study.

A factor of equal importance is reliability or repeatibility. To what degree would a retrospective study be replicated if a completely different team were involved in its construction? If each team were to construct a completely different retrospective study for the same topic, then what meaning or credibility or value can be assigned to any retrospective study? To minimize repeatibility problems, a reasonably sizeable segment of the competent technical community should be involved in the construction and review of the the retrospective study. For government-constructed retrospective studies, this does not present a conceptual problem, although it might present a logistics problem for sufficiently large community involvement. For industry-constructed retrospective studies, where proprietary problems could arise if the external community becomes involved, the participation may have to be limited. The recommendation should be re-interpreted as 'to the degree possible within organizational constraints'.

A sixth critical factor for quality retrospective studies is cost. The true total costs of developing a high quality retrospective study with substantial community input can be considerable, but tend to be understated. For high quality retrospective studies, where sufficient expertise is represented on the study team, the major contributor to total costs is the time of all the individuals involved in developing and reviewing the retrospective study. With high quality personnel involved in the development and review process, time costs are high, and the total study costs can be non-negligible. Costs should not be neglected in designing a high quality retrospective study development process.

The final critical factor, and perhaps the foundational factor, in high quality retrospective study development is the maintenance of high ethical standards throughout the process. There is a plethora of potential ethical issues, because there is an inherent bias/ conflict of interest in the process when real experts are desired as retrospective study performers and reviewers. The retrospective study development managers need to be vigilant for undue signs of distortion aimed at personal gain.

SEMI-QUANTITATIVE METHODS CONCLUSIONS

Hindsight, TRACES, and, to some degree, the OHER and DARPA accomplishments books had some similar themes. All these methods used a historiographic approach, looked for significant research or development events in the metamorphosis of research programs in their evolution to products, and attempted to convince the reader that: (1) the significant research and exploratory development events in the development of the product or process were the ones

identified; (2) typically, the organization sponsoring the study was responsible for some of the (critical) significant events; (3) the final product or process to which these events contributed was important; and (4) while the costs of the research and development were not quantified, and the benefits (typically) were not quantified, the research and development were worth the cost.

Six critical conditions for innovation were identified through analysis of these retrospective studies. The most important condition appears to be **the existence of a broad pool of knowledge which minimizes critical path obstacles** and can be exploited for development purposes. This condition is followed in importance by a **technical entreprenuer who sees the technical opportunity and recognizes the need for innovation**, and who is willing to champion the concept for long time periods, if necessary. Also valuable are **strong financial and management support** coupled with **many continuing inventions in different areas** to support the innovation.

As the historiographic analyses (Hindsight/ TRACES) of a technology or system have shown, if the time interval in which the antecedent critical events occur is arbitrarily truncated, as in the two-decade time interval Hindsight case, the impacts of basic research on the technology or system will not be given adequate recognition. The number of mission oriented research events peaks about a decade before the technology innovation. However, the number of non-mission oriented research events peaks about three decades before the technology innovation, and eight, nine, or more decades may be necessary in some cases to recognize the original critical antecedent events. Over a long time interval, the majority of key R&D events tend to be non-mission oriented. Thus, future studies of this type should allow time intervals of many decades to insure that critical non-mission oriented research events are captured.

Even in those cases when an adequate time interval was used, and critical non-mission oriented events were identified, the cumulative indirect impacts of basic research were not accounted for by any of the retrospective approaches published or in use today. A recent study [Kostoff, 1994i] which examined impacts of research on other research and technology through direct and indirect paths using a network approach showed that the indirect impacts of fundamental research can be very large in a cumulative sense. Future retrospective studies would be more credible if they devote more effort to identifying indirect impacts of research. While indirect impacts of research are much more difficult to identify than direct impacts, and the data gathering effort is much larger and more complex, neglect of indirect impacts reduces appreciation of the value of basic research significantly. Use of some of the advanced computer-based technologies available today, such as the network approach referenced above or citation analysis [Narin, 1989], could identify many of the pathways of the indirect impacts of research.

A detailed reading of those studies which attempted to incorporate economic quantification showed the difficulties of trying to identify, assign, and quantify costs and benefits of

basic research, especially at a project/investigator level. As TRACES and other similar studies have shown, the chain of events leading to an innovation is long and broad. Many researchers over many years have been involved in the chain, and many funding agencies, some simultaneously with the same researchers, may have been involved. The allocation of costs and benefits under such circumstances is a very difficult and highly arbitrary process. The allocation problem is reduced, but not eliminated, when the analysis is applied at the macro level (integrating across individual researchers, organizations, etc.).

One goal of all the studies presented was to identify the products of research and some of their impacts. The Hindsight, TRACES, and ARPA studies tried to identify factors which influenced the productivity and impact of research. The following conclusions about the role and impact of basic research were reached:

1. The majority of basic research events which directly impacted technologies or systems were non-mission oriented and occurred many decades before the technology or system emerged;
2. The cumulative indirect impacts of basic research were not accounted for by any of the retrospective approaches published;
3. An advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur;
4. Allocation of benefits among researchers, organizations, and funding agencies to determine economic returns from basic research is very difficult and arbitrary, especially at the micro level.

While these approaches do provide interesting information and insight into the transition process from research to development to products, processes, or systems, the **arbitrary selectivity and anecdotal nature of many of the results render any conclusions as to cost-effectiveness or generalizability suspect.** Supplementary analyses using other approaches are required for further justification of the value of the R&D.

QUANTITATIVE METHODS SUMMARY

Quantitative approaches to research assessment focus on the numerics associated with the performance and outcomes of research. The main approaches used are bibliometrics and econometrics such as cost-benefit and production function analysis. This summary focuses on these three main approaches, briefly describes the bibliometrics-related family of approaches known as co-occurrence phenomena, briefly describes a network modeling approach to quantifying research impacts, and ends with an expert systems approach for supporting research assessment.

BIBLIOMETRICS

Bibliometrics, especially evaluative bibliometrics, uses counts of publications, patents, citations and other potentially

informative items to develop science and technology performance indicators. The choice of important bibliometric indicators to use for research performance measurement may not be straightforward. A 1993 study surveyed about 4,000 researchers to identify appropriate bibliometric indicators for their particular disciplines [Australia, 1993]. The respondents were grouped in major discipline categories across a broad spectrum of research areas. While the major discipline categories agreed on the importance of publications in refereed journals as a performance indicator, there was not agreement about the relative values of the remaining 19 indicators provided to the respondents. For the respondents in total, the important performance indicators were:

1. Publications (publication of research results in refereed journals);
2. Peer Reviewed Books (research results published as commercial books reviewed by peers);
3. Keynote Addresses (invitations to deliver keynote addresses, or present refereed papers and other refereed presentations at major conferences related to one's profession);
4. Conference Proceedings (publication of research results in refereed conference proceedings);
5. Citation Impact (publication of research results in journals weighted by citation impact);
6. Chapters in Books (research results published as chapters in commercial books reviewed by peers);
7. Competitive Grants (ability to attract competitive, peer reviewed grants from the ARC, NH&MRC, rural R&D corporations and similar government agencies).

These bibliometric indicators can be used as part of an analytical process to measure scientific and technological accomplishment. Because of the volume of documented scientific and technological accomplishments being produced (5,000 scientific papers published in refereed scientific journals every working day worldwide; 1,000 new patent documents issued every working day worldwide), use of computerized analyses incorporating quantitative indicators is necessary to understand the implications of this technical output [Narin, 1994].

Narin states three axioms that underlie the utilization and validity of bibliometric analysis. The first axiom is **activity measurement:** that counts of patents and papers provide valid indicators of R&D activity in the subject areas of those patents or papers, and at the institution from which they originate. The second axiom is **impact measurement:** that the number of times those patents or papers are cited in subsequent patents or papers provides valid indicators of the impact or importance of the cited patents and papers. However, there could be weightings applied to the raw count data, depending on the perceived importance of the journals containing the citing papers. Also, the impacts would be on allied research fields or technologies, not necessarily long-term impacts on the originating organization's mission. The third

axiom is **linkage measurement:** that the citations from papers to papers, from patents to patents and from patents to papers provide indicators of intellectual linkages between the organizations which are producing the patents and papers, and knowledge linkage between their subject areas [Narin, 1994].

Use of bibliometrics can be categorized into four levels of aggregation [Narin, 1994]:

1. policy (evaluation of national or regional technical performance);
2. strategy (evaluation of the scientific performance of universities or the technological performance of companies);
3. tactics (tracing and tracking R&D activity in specific scientific and technological areas or problems);
4. conventional (identifying specific activities and specific people engaged in research and development).

Policy questions deal with the analysis of very large numbers of papers and patents, often hundreds of thousands at a time, to characterize the scientific and technological output of nations and regions. Strategic analyses tend to deal with thousands to tens of thousands of papers or patents at a time, numbers that characterize the publication or patent output of universities and companies. Tactical analyses tend to deal with hundreds to thousands of papers or patents, and deal typically with activity within a specific subject area. Finally, conventional information retrieval tends to deal with identifying individual papers, patents, inventors and clusters of interest to an individual scientist or engineer or research manager working on a specific research project.

The first, and major, step in the performance of a high quality bibliometric analysis in any of the above four levels of aggregation is acceptance by the potential user of the above three axioms to validate the credibility of the bibliometric approach. Once this hurdle has been passed, the second step is to select the highest quality and reliability raw indicator products (data and databases) and apply analyses of the highest statistical precision and accuracy to these indicators [Braun, 1989, 1990, 1993]. The third step, which in many cases will determine the utility of the results, is the interpretation and visual display of the results. The results of the most stringent analyses will be relatively worthless if they are not displayed in a concise and lucid form.

Indicators can be arranged in one or more dimensions. Emphasis has always been laid on the necessity of multidimensional thinking while analyzing scientometric indicators. Scientific research is a multifaceted human activity, and overemphasizing any of its aspects (publication productivity, citation influence, technological applicability, etc.) may lead to serious distortions in its assessment. While each scientometric indicator represents a single component of a multidimensional manifold which itself is just one element in assessing a complex system, presentations in one or several dimensions may equally prove useful [Braun, 1993].

The most direct way of presenting scientometric indicators is

in one dimensional ranked lists. While simplistic, this approach reflects the paramount competitiveness of the scientific enterprise. Linear rankings are most attractive for presentation to the larger non-specialist audience (see Braun [1993]).

Two dimensional displays can include relational charts or scatter plots for correlations. In two dimensional relational charts [Schubert, 1986; Braun, 1987], pairs of indicators (observed vs. expected citation rates or attractivity vs. activity indices)are displayed in a planar orthogonal coordinate system. Emphasis is shifted from ranking to the formation of groups or 'clusters' and other characteristic relations among various indicators.

An obvious deficiency of the relational charts is the lack of any indication of the size of the sets of publications underlying the points of the diagram. By adding the third dimension of publication size, this objection can be overcome. The basic idea of 'landscaping' national scientific performances is to represent the size by the 'mass' of a mountain-like formation. If two or more countries have similar citation characteristics, the peaks representing them may get superimposed forming chains, massifs, and other surface formations. An example is presented in Braun [1991].

There seems to be a natural limit of graphical presentation at three dimensions. There are techniques, however, to overcome this apparent restriction. A rather original method of representing multivariate data was proposed by Herman Chernoff: "Each point in k-dimensional space, k<=18, is represented by a cartoon face whose features, such as length of nose and curvature of mouth correspond components of the point. Thus every multivariate observation is visualized as a computer drawn face. This presentation makes it easy for the human mind to grasp many of the essential regularities and irregularities present in the data."

Braun [1993] shows a face pattern with 18 facial features applicable in representing multidimensional data. Schubert [1992] contains a four-dimensional example of applying Chernoff-faces in scientometrics: uncitedness, citation rate per cited paper, mean expected citation rate and relative citation rate are represented by the shape of face, size of eyes, length of nose and curvature and length of mouth, respectively.

Problems with publication and citation counts include [King, 1987; Oberski, 1988; OTA, 1986; White, 1989]:

A) Publication counts:

1. indicates quantity of output, not quality;
2. non-journal methods of communication ignored;
3. publication practices vary across fields, journals, employing institutions;
4. choice of a suitable, inclusive database is problematical;
5. undesirable publishing practices (artificially inflated numbers of co-authors, artificially shorter papers) increasing.

B) Citations:

1. intellectual link between citing source and reference article may not always exist;
2. incorrect work may be highly cited;
3. methodological papers among most highly cited;
4. self-citation may artificially inflate citation rates;
5. citations lost in automated searches due to spelling differences and inconsistencies;
6. Science Citation Index (SCI) changes over time;
7. SCI biased in favor of English language journals;
8. same problems as publication counts.

In addition, one of the main concerns with using citations as a stand-alone measure of quality and impact has been the potential bimodal interpretation of the numerical results. A paper could receive high citations because of its high quality, or because the citers disagree with it. However, there is a third interpretation which further precludes citations being utilized in stand-alone mode, which the author has termed the "Pied Piper" effect.

Assume there is a present-day mainstream approach in a specific field of research; for example, the chemical/ radiation/ surgical approach to treating cancer (See section IV-C-3 for a more detailed example of the "Pied Piper Effect"). Assume that in, say, fifty years a cure for cancer is discovered, and the curative approach has nothing to do with today's research. In fact, assume it turns out that today's approach was completely orthogonal or even antithetical to the correct approach. Then what meaning can be ascribed to research papers in cancer today which are highly cited for supposedly positive reasons?

In this case, a paper's citations are a measure of the extent to which the paper's author has persuaded the research community that the research direction contained in his paper is the correct one, and not a measure of the intrinsic correctness of the research direction. In fact, the citations may reflect the desire of a closed research community (the author and the citers) to persuade a larger community (which could include politicians and other resource allocators) that the research direction is the correct one. This is the "Pied Piper" effect. The large number of citations in the above hypothetical medical example becomes a measure of the extent of the problem, the extent of the diversion from the correct path, not the extent of progress toward the solution. The "Pied Piper" effect is a key reason why, especially in the case of revolutionary research, citations and other quantitative measures must be part of and subordinate to a broadly constituted peer review in any credible evaluation and assessment of research impact and quality.

There are few Federally-supported bibliometric studies reported in the literature. In addition to the above problems, another reason for limited Federal use can be inferred from Narin [1976], where studies on the publication and citation distribution functions for individuals are reviewed. The conclusion drawn, from studies such as those of Lotka, Shockley, De Solla Price, and Cole and Cole, is that **very few of the active researchers are producing**

the heavily cited papers. How motivated are funding agencies to report these hyperbolic productivity distributions for different programs in the open literature, especially since many questions exist as to the accuracy and completeness of the bibliometric indicators? This conclusion raises the further question of the role actually played by the less productive researchers (as measured by publication and citation counts): is the productivity of the elite somehow dependent on the output of the less influential, or is the role of the less productive members that of maintaining the stability of the research infrastructure and educating future generations of researchers?

Macroscale bibliometric studies characterize science activity at the national [e.g., Hicks, 1986; Braun, 1989], international, and discipline level. The biennial Science and Engineering Indicators report [NSF, 1989] tabulates data on characteristics of personnel in science, funds spent, publications and citations by country and field, and many other bibliometric indicators. Another study at the national level was aimed at evaluating the comparative international standing of British science [Martin, 1990]. Using publication counts and citation counts, the authors evaluated scientific output of different countries by technical discipline as a function of time. Much more understanding is required as to which indicators are appropriate and how they should impact allocation decisions.

There have been numerous microscale bibliometric studies reported in the literature [e.g., Frame, 1983; McAllister, 1983; Mullins, 1987, 1988; Moed, 1988; Irvine, 1989; Van Raan, 1989; Luukkonen, 1990a, 1990b, 1992]. The NIH bibliometric-based evaluations [OTA, 1986] included the effectiveness of various research support mechanisms and training programs, the publication performance of the different institutes, the responsiveness of the research programs to their congressional mandate, and the comparative productivity of NIH-sponsored research and similar international programs.

Two papers [Narin, 1987b, 1989] described determination of whether significant relationships existed among major cancer research events, funding mechanisms, and performer locations; compared the quality of research supported by large grants and small grants from the National Institute of Dental Research; evaluated patterns of publication of the NIH intramural programs as a measure of the research performance of NIH; and evaluated quality of research as a function of size of the extramural funding institution. Most of the NIH studies focused on aggregated comparison studies (large grants vs small, large schools vs small schools, domestic vs foreign, etc).

Patent citation analysis has the potential to provide insight to the conversion of science to technology [Carpenter, 1983; Narin, 1984; Wallmark, 1986; Collins, 1988; Narin, 1988c; Van Vianen, 1990; Narin, 1992]. Much of the Federal government support of the development of patent citation analysis was by the NSF [e.g., Carpenter, 1980; Narin, 1987a]. Some recent studies have focused on utilization of patent citation analysis for corporate

intelligence and planning purposes (e.g., Narin, 1992b). Some of the data presented verify further Lotka's Productivity Law, where relatively few people in a laboratory are producing large numbers of patents. In the example presented in Narin [1992b], the patents of the most productive inventor are highly cited, further demonstrating his key importance. Narin concludes that highly productive research labs are built around a small number of highly productive, key individuals.

Despite its limitations, bibliometrics may have utility in providing insight into research product dissemination. For laboratories, these studies include:

1. Examine distribution of disciplines in co-authored papers, to see whether the multidisciplinary strengths of the lab are being utilized fully;
2. Examine distribution of organizations in co-authored papers, to determine the extent of lab collaboration with universities/ industry/ other labs and countries;
3. Examine nature (basic/ applied) of citing journals and other media (patents), to ascertain whether lab's products are reaching the intended customer(s);
4. Determine whether the lab has its share of high impact (heavily cited) papers and patents, viewed by some analysts as a requirement for technical leadership;
5. Determine which countries are citing the lab's papers and patents, to see whether there is foreign exploitation of technology and in which disciplines;
6. Identify papers and patents cited by the lab's papers and patents, to ascertain degree of lab's exploitation of foreign and other domestic technology.

A recent comparative bibliometric analysis of 53 laboratories [Miller, 1992] clustered the labs into six types (Regulation and Control, Project Management, Science Frontier, Service, Devices, Survey), and stated that "comparisons of scientific impacts should be made only with laboratories that are comparable in their primary task and research outputs". The report concluded further that:

1. Bibliometric indicators and scientific publications are not the only outputs that should be measured, but the other types of outputs differ for different labs;
2. Bibliometric indicators are not equally valid across different types of laboratories;
3. Bibliometric indicators are less useful for the evaluation of research laboratories involved in closed publication markets.

Potential Normalization Approaches

A major problem with bibliometrics is comparisons of outputs of different performers (or performing organizations) who may also work in different disciplines. Three types of normalization solutions to allow cross-organization or cross-discipline

comparisons are proposed by Schubert [1993]. In addition, the author has recently generated a new approach for comparing citation rates across different disciplines [Kostoff, 1997m], and excerpts are contained in Section IV-C-2.

1. The Publishing Journal as Reference Standard

By relating the number of citations received by a paper (or the average citation rate of a subset of papers published in the same journal - the **Mean Observed Citation Rate**) to the average citation rate of all papers in the journal (the **Mean Expected Citation Rate**) the **Relative Citation Rate** will be obtained. This indicator shows the relative standing of the paper (or set of papers) in question among its close companions: it value is higher\lower than unity as the sample is more\less cited than the average.

2. The Set of Related Records as Reference Standard

"Bibliographic Coupling" uses the number of references a given pair of documents have in common to measure the similarity of their subject matter. Comparing a set of papers that are "similar" in this sense to a given article of the same age will yield an ideal reference standard for citation assessments.

3. The Set of Cited Journals as Reference Standard

A promising method is based on the **journal in the reference lists of the articles of the journal in question.** These journals are selected by the most reliable persons, the authors of the journal as references (in both senses of the word) and therefore, can justly be regarded as standards of the expected citation rate.

CO-OCCURRENCE PHENOMENA

One class of computer-based analytic techniques which tends to focus more on macroscale impacts of research exploits the use of co-occurrence phenomena. In co-occurrence analysis, **phenomena that occur together frequently in some domain are assumed to be related, and the strength of that relationship is assumed to be related to the co-occurrence frequency.** Networks of these co-occurring phenomena are constructed, and then maps of evolving scientific fields are generated using the link-node values of the networks. Using these maps of science structure and evolution, the research policy analyst can develop a deeper understanding of the interrelationships among the different research fields and the impacts of external intervention, and can recommend new directions for more desirable research portfolios. These techniques are discussed in more detail in Kostoff [1992a- Appendix III, 1993c, 1994f]; Tijssen [1994]. The Tijssen paper contains an excellent exposition on mapping techniques for displaying the structure of related science and technology fields.

In particular, co-citation analysis has been applied to scientific fields, and co-citation clusters have been mapped to represent research-front specialties [Tijssen, 1994]. Co-word has

been utilized to map the evolution of science under European (mainly French) government support, and has the potential to supplement other research impact evaluation approaches. Co-nomination, in its different incarnations, has been used to construct social networks of researchers and has the potential, if expanded to include research and technology impacts in the network link values, for evaluating direct and indirect impacts of research. Co-classification is based on co-occurrences of classification codes in patents, and is used to construct maps of technology clusters [Engelsman, 1991].

COST-BENEFIT/ ECONOMIC ANALYSES

A comprehensive survey examined the application of economic measures to the return on research and development as an investment in individual industries and at the national level [OTA, 1986]. This document concluded that while econometric methods have been useful for tracking private R&D investment within industries, the methods failed to produce consistent and useful results when applied to Federal R&D support. A more recent analysis focused on economic/ cost-benefit approaches used for research evaluation [Averch, 1994]. The methods involve computing impacts using market information, monetizing the impacts, then comparing the value of the impacts with the cost of research. Principal measures described include surplus measures and productivity measures. With known benefit and cost time streams, internal rates of return to R&D investments are then computed. The paper notes both the standard technical difficulties with these approaches and the political and organizational difficulties in implementing them.

Cost-Benefit

Cost-benefit analyses are a family of related techniques which include Cost-Benefit, Net Present Value, and Rate-of-Return [Link, 1993; Roessner, 1993; Averch, 1994]. These approaches tend to be more widely used in industry than government. For one, or many, projects, the basic approach is similar. A starting point in time for the research is defined. The time stream of costs for product development is estimated, and the time stream of benefits from the product is estimated. Using the time value of money, the costs and benefits are discounted to the origin of time, and the net benefits are compared with the net costs. The main differences in the approaches to cost benefit analyses are in the sophistication of the methods used to estimate the cost and benefit streams, and the time value of money.

Cost-benefit analyses have limited accuracy when applied to basic research because **of the quality of both the cost and benefit data due to the large uncertainties characteristic of the research process, as well as selection of a credible origin of time for the discounting computations.** As an illustrative example, a deterministic cost-benefit analysis was performed by the author on a fusion reactor variant [Kostoff, 1983]. Its **real problem, which pervades and limits any attempt to perform a cost-benefit analysis**

on a concept in the basic research stage, was the inherent uncertainty of controlling the fusion process. This translated to the inability to predict the probabilities of success and time and cost schedules for overcoming fundamental plasma research problems (e.g., plasma stabilities and confinement times); no credible methods were available. Thus, the main value of the cost-benefit approach was to show that the potential existed for positive payoff from the hybrid reactor development, that there was a credible region in parameter space in which controlled fusion development could prove cost effective; what was missing was the likelihood of achieving that payoff.

A 1991 marginal cost-benefit study weighed the costs of academic research against the benefits realized from the earlier introduction of innovative products and processes due to the academic research [Mansfield, 1991]. The study used survey data to show a very high social rate of return resulting from academic research. While the method is innovative, future applications using more objective data sources would provide higher confidence in the computed rates of return.

Production Function

Production function approaches to evaluating research returns invoke economic theory-based assumptions relating outputs to inputs to generate an estimatable model. One only needs time series data on output, capital, labor, and research expenditures to estimate empirically the marginal contribution of research to value added. However, the relationship of research to value added is non-linear and indirect. Variables such as other inputs to technology and production and marketing functions complicate the research/ value added relationship.

Much of the major recent economic work relating economic growth/ productivity increases to R&D spending has been performed by three economists [Mansfield, 1980, 1991; Terleckyj, 1977, 1985; Griliches, 1979, 1994]. Mansfield's earlier study typifies the strengths and weaknesses of the production function approach. This study [Mansfield, 1980] attempted to determine whether an industry's or firm's rate of productivity change was related to the amount of basic research it performed. Mansfield developed a production function which disaggregated basic and applied research, then regressed rate of productivity increase with many different variables. The regressions showed a strong relationship between the amount of basic research carried out by an industry and the industry's rate of productivity increase during 1948-1966.

The study exemplifies the problem inherent in multiple regression analyses: that of determining cause and effect from what is essentially correlation. As Mansfield points out, "It is possible that industries and firms with high rates of productivity growth tend to spend relatively large amounts on basic research, but that their high rates of productivity growth are not due to these expenditures" [Mansfield, 1980]. Nor does Mansfield's model specify the path(s) by which R&D investment supposedly leads to productivity improvements.

A production function approach to cost-efficiency of basic research essentially used a regression analysis between outputs and inputs [Averch, 1987, 1989]. For proposals, the method involved regressing output variables (citations per dollar, graduate students per dollar) against input variables (e.g., quality of the investigator's department, quality of the investigator, etc.). The results gave some idea of the importance of the input variables, alone or in combination, on the output variables. One obvious potential application would be prediction of proposals likely to have high productivity based on prior (input) knowledge. **Much, however, remains to be done in identifying the appropriate output measures, the appropriate input measures, and the nature of the interactions among these measures for different disciplines.**

NETWORK MODELING FOR DIRECT/INDIRECT IMPACTS

A network based modeling approach was devised which would allow estimation of the direct and indirect impacts of a research program or collection of research programs. The research program impacts would be multi-faceted, including impacts on advancing its own field, on advancing allied fields, on advancing technology, on supporting operations and mission requirements, etc. A major feature of the model is **inclusion of feedback from the higher development categories (e.g., exploratory development, advanced development) on the advancement of research.**

The model and a subsequent pilot study related to Navy R&D have been described in detail [Kostoff, 1994i]. In summary, a network was constructed in which each node represented an area of research or development. The values of the links connecting each node pair represented the impact of results from the first node area on the second node area. The total impact of an area of research on other research or development was obtained by integrating over all paths from the research node to the node(s) of interest.

EXPERT NETWORKS

Research Impact Assessment is, at its essence, a diagnostic process with many diagnostic tools. In other fields of endeavor, such as Medicine and Machinery Repair, expert systems are increasingly being used as diagnostic tools or as support to diagnostic processes. Recently, there have been efforts to develop expert system approaches combined with artificial neural networks (expert networks) for use in R&D management, including RIA [Odeyale, 1993; Odeyale and Kostoff, 1994a, 1994b]. A brief summary of these efforts follows.

The product of these efforts is Research-Management Expert Network (**R-MEN**) which is characterized by two complementary tools: Organizational/Professional Development and Expert Network. The latter technology is comprised of an expert system (left side brain) and an artificial neural network (right side brain). Given a set of research, and research management policies and strategies,

R-MEN learns concepts that hierarchically organize those policies and strategies and use them in classifying/triaging research proposals.

The framework of Research-Management Expert Network (R-MEN) consists of a knowledge base and a data base. Feeding into the knowledge base are four modules: a policy/ strategy impartation module and a proposal data acquisition module, both of which receive input from the O/PD process; and a research impact calculation module and a proposal review module. The knowledge base then feeds into the data base through five modules: a project selection module, resources allocation module, project evaluation and control module, investigator evaluation module, and organization evaluation module.

R-MEN is implemented in three phases. Phase 1 includes the development of the strategic plan, which defines and communicates longer-term research directions, and the development of the operating plan, which specifically identifies the projects that will implement the strategic plan taking into consideration the goals, quantifiable objectives and development of the individual investigator and the organization.

Phase 2 represents the necessary education, and management support needed to prepare the staff to participate in such an "Action Research" effort. This phase identifies and utilizes the critical components required to develop an environment that facilitates participative research management activities. A significant activity occurring during this phase is daily verification of individual scheduled training and development. If an individual has no recorded training and/or development within a preset period, the system will generate and send a report through E-mail directly to the office of the director for R&D. The system will be able to look at a training and/or development description(s) and compare it/them with the background of the individual to determine if the training and/or development is/are suitable for that individual.

Phase 3 represents a means by which participative methods can be put into operation in developing productivity tracking systems. Significant activities occurring during this phase include project evaluation and control. This entails periodic monitoring of project milestones for applied research, and research objectives for the more basic research. If a project has no recorded fulfillment of a milestone within a preset period, the system will generate and send a report through E-mail directly to the office of the director for R&D.

If **R-MEN** is initially used concurrently with present research review processes, it will serve as a supplement in the form of a guide to data generation, acquisition and processing, and a validity check. With appropriate implementation and maintenance, this knowledge technology, which utilizes demonstrated and proven approaches, methods, procedures and techniques in an innovative and unique way, could lead to the following benefits:

1. Provide a means for **effective**, policy- and strategy-

oriented management through outcomes-management.

2. Improve management quality, reduce operation costs, and increase productivity and public trust.

3. Foster impact evaluation to document Federally funded program and management effectiveness.

4. Provide short-term (three-year) program progress tracking and long-term (ten-year) result(s) impact tracking.

5. Shield administrators, managers, and other policy-makers from the complexity of the mathematics of the inference machine.

6. Permit the evaluation of a range of alternatives.

7. Permit handling large amounts of data.

8. Permit policy-makers to have a better understanding of existing technical attributes of and capabilities for potential projects.

9. Facilitate choice of strategy compatible with agency structure and processes, and with the policy or the nature of decision making for activities scheduling and control.

QUANTITATIVE METHODS CONCLUSIONS

Bibliometric methods are valuable in quantifying the output of research. Because they do not address quality, and their numeric outputs are subject to multiple interpretations, they are not self-contained assessment methods. They are a valuable supplement to the subjective interpretative methods such as peer review.

Economic approaches have limited value when applied to assessing the potential of fundamental research, because of the uncertain nature of the data. Their validity increases as the research becomes more applied, and cost and benefit streams can be estimated more accurately.

As databases become more extensive, and computer power continually increases, data intensive quantitative analyses will increase in use. Approaches such as co-occurrance, network modeling, and expert networks described above will become more commonplace in research assessment.

For those fields of technology in which patents are an important mode of communication, patent citation analysis offers insight into the conversion of science to technology. Many of the reported patent citation analysis studies tend to focus on technical intelligence for corporate applications [Narin, 1994].

RESEARCH REQUIREMENTS FOR RIA SUMMARY

More retrospective studies are required using modern technologies such as information processing and computerized citation databases. The tracing of the indirect impacts of research should be emphasized. Network approaches are valuable in this regard. More rigorous peer review experiments should be performed, to understand better the issues of cost, validity, reliability, quality, and feedback. The text describes the main parameters to be examined in these studies. For bibliometrics, studies are required to address the normative comparisons across

different disciplines, as well as to examine optimal ways to combine multiple indicators into few figures of merit.

Central to the assessment of research is the capability to handle all phases of the information creation, flow, and integration cycle. The explosion of available information in the last decade requires the utilization of large databases to handle this information in support of RIA.

In particular, sophisticated data collection, analysis, and interpretation schemes can track the dissemination of information flowing from research to other applications. A credible research product tracking scheme can help identify the indirect impacts of research more precisely, and can improve correlations between research evaluation predictions (such as peer review and bibliometrics) and downstream impacts.

Central to credible work in predicting and tracking the diffusion of information from research is a database of research products at various evolutionary stages which can feed the predictive models. This database of research products could be linked in part with databases of sponsored research and technology. Since the research product evolutionary pathways transcend the research originating organization, and can intersect all societal sectors, the cooperation of many public and private organizations would be required to develop a database of research products in their evolutionary stages. Development and construction of such a database should start now.

Comprehensive databases describing sponsored research and development programs in many funding agencies and organizations, with sophisticated software to provide rapid access to the database contents, can help improve the selection, management, and evaluation of research programs. Research gaps can be identified, duplication of programs can be minimized, complementary and joint programs can be established, substantial leveraging of other agency programs can be implemented, and technology planning can be improved with better awareness of maturing research programs.

To fully understand a research program, especially in the assessment of that program, evaluators must be cognizant of the large body of research being conducted throughout the world. In addition, to fully understand the impacts of research on different technologies, evaluators must be cognizant of the large body of existing and developmental technology throughout the world, and the existing and potential shortcomings in those technologies.

With the advent of high speed and high storage capacity computers, and advances in database software packages, the capability exists now to make large amounts of information available to researchers and evaluators. In particular, the capability exists to provide information about funded research and technology development programs being conducted throughout the world, as well as information about existing technologies.

Tailored databases which contain information about the structural relationships among projects and programs can help identify critical paths for development in R&D programs. This is important in allocating resources among programs in mission-

oriented agencies and other organizations.

Sophisticated algorithms for manipulating and interpreting large technical textual databases would allow pervasive themes of the databases to be identified, as well as the relationships among the themes and sub-themes. Low frequency anomolous relationships which could be important are identified easily with these techniques. The algorithms would also allow identification of the translations between research areas and technology areas in the databases, and would provide guidelines and roadmaps for increasing the efficiency of searching unfamiliar databases.

These algorithms, and subsequent analyses, have the potential of identifying emerging research and development areas contained within the databases but not readily discernable. The software can also help in taxonomy construction, with the taxonomy elements obtained 'bottom-up' from the database language, rather than top down using an authoritative directed approach. Many different types of taxonomies could be constructed from the full text database, and relationships among the different elements of the different taxonomies could be obtained. Finally, by looking at the changes in the structure of research fields over time, the impact of sponsoring organization intervention can be ascertained.

RIA OPTIONS SUMMARY

This final Handbook section spans topics ranging from investment strategy and evaluation protocols to algorithms for allocating funds based on quantitative evaluation results. In this section, the research evaluation guidance recommended for Federal agencies is described. While the focus of this section is on Federal agency evaluations, the principles and implementation mechanics are sufficiently broad to be applicable to most organizations.

III. INTRODUCTION

Research is the pursuit and production of knowledge by the scientific method. Research Productivity is the generation of tangible and intangible products from research. Research Efficiency is the productivity of research per unit of input resource. Research Impact is the change effected on society due to the research product. Research Effectiveness is a measure of the focus of impact on desired goals.

The underlying value in the practice of research is truth. What achieves truth most efficiently is the most value. The underlying value in the administration of research is utility. What is most useful, in addition to being true, is the most valuable. In the administration of basic research, usefulness to neighboring sciences is the main guiding criterion. Those basic scientific activities that impart unity to science are to be preferred to those that do not. Unity is the ultimate value in the formulation of a grand strategy for basic research [Weinberg,1989].

To measure the impact of research requires the measurement of

knowledge. However, knowledge cannot be measured directly. What can be observed and measured are the **expressions** of knowledge, such as papers, patents, and students educated. Measures of the expressions of knowledge resulting from research must of necessity provide an incomplete picture of the research product. The concluding hypothesis that will permeate the remainder of this Handbook is that the greater the variety of measures and qualitative processes used to evaluate research impact, the greater is the likelihood of converging to an accurate understanding of the knowledge produced by research [Irvine, 1984].

Impact of a research program involves identifying the variety of expressions of knowledge produced, as well as the changes which these expressions effect on a multitude of different potential research targets (other research areas, technology, systems, operations, other organizational missions, education, social structures, etc.). While some impacts may be tangible (new instruments developed, new research fields stimulated, students trained in new disciplines), many may be intangible (e.g., a designer of equipment may receive new insights from having attended a research seminar), and difficult to identify, much less quantify.

Evaluation of research impact is further complicated by the different perspectives and motivations of the assessors. The quantitative approaches require interpretation by the assessors, and the qualitative approaches rest on the purely subjective judgements of the assessors. The importance of a research program represents a weighting of its quantitative and qualitative impacts on the different potential targets of research. Yet this weighting is dependent on the multiple perspectives of the assessors, including technical, organizational, and personal perspectives [Linstone, 1989], and the interplay among these perspectives is not always obvious. Thus, not only is the impact of the research on each of its potential targets dependent on some unknown function of the multiple perspectives of the assessors, but the value and relative ranking of the targets depends on these multiple perspectives as well. Selection of technical methodologies, measures, and assumptions by the assessors may be driven significantly by organizational and personal motivations.

Understanding and measures of the impact of research are desired by research sponsors at every stage of the research cycle, including research topic identification, research selection, research management and evaluation, and research termination/ transition and retrospective analysis. Research impact evaluations are of potential use to sponsors in: "Deciding whether to continue or end the program or to increase or decrease its budget; changing the program, or its management, to improve the probability of success; altering policies regarding the procurement, conduct, or management of research; and/or, building support with policy makers and other constituencies of the program" [Salasin, 1980].

In terms of actual use, a major 1985 survey of strategic evaluation methods for research programs concluded:

"Peer review is generally considered the touchstone of

research program evaluation techniques. Bibliometric techniques have demonstrated considerable utility for research program evaluation; many studies recommend that they be used in conjunction with other techniques. Econometric methods are frequently propounded, but save for cost-benefit analysis, most of these techniques have not received widespread currency for evaluating research programs... Based upon our review of the literature, it would appear that formal, strategic evaluation of research programs is not performed on a regular basis in either government or industrial laboratories. Government funding programs are evaluated on an irregular basis as well. We surmise that much evaluation is informal and non-technique oriented and hence not reported outside of the organization which conducts it" [Kerpelman, 1985].

There are many bibliographies containing the large number of methods developed to evaluate research conduct, impact, and benefits [Wirt, 1974; Salasin, 1980; Gibbons, 1985; Logsdon, 1985; Kerpelman, 1985; OTA, 1986; Gibbons, 1987; Luukkonen-Gronow, 1987; Averch, 1990; Hall, 1990; Johnston, 1990; OTA, 1991; Kostoff, 1991c, 1991e, 1992a, 1993b, 1992d, 1994l]. A relatively small fraction of the methods are actually used in practice by Federal research sponsors and evaluators. Of those used in practice, only a small fraction of the results of impact studies are reported in the published literature, and an even smaller fraction are accepted by the final Federal decision-makers. While a number of the methods in practice actually used by Federal research sponsors to measure impact will be described in the remainder of this Handbook, one objective will be to **focus on the strengths and weaknesses of these selected methods.**

IV. RESEARCH IMPACT EVALUATION TECHNIQUES

Luukkonen-Grunow [1987] and Averch [1990] provide summaries of major research evaluation methods used throughout the world. The three main categories, in frequency of usage order, are: **Peer Review, Non-Quantitative Case Study and Anecdotal Approaches, and Quantitative Methods.** Specific variants of the qualitative, semi-quantitative, and quantitative methods are described, and examples of the more prominent applications in the U. S. are presented.

IV-A. QUALITATIVE METHODS (PEER REVIEW)

IV-A-1. PEER REVIEW BACKGROUND AND ISSUES

Introduction

Peer review of research is overwhelmingly the method of choice in practice in the U. S., as well as the rest of the world [Salasin, 1980; Logsdon, 1985; Chubin, 1990; Chubin, 1994; Kostoff, 1995a; Stamps, 1997a]. Its objectives range from being an efficient resource allocation mechanism to a credible predictor of research impact. Due to the pressures for increased accountability of federal research expenditures, there is the potential for use of

research program peer review to increase substantially in the near future. Before the peer review specifics are addressed, reasons for the potential increased use will be discussed.

In 1993, the Government Performance and Results Act (GPRA) was enacted into law [GPRA, 1993]. GPRA applies to all federal outlay programs, and has three components: strategic plans, annual performance plans, and metrics to show how well the annual plans are being met. Since the plan became law, there have been many federal interagency meetings to ascertain how the third requirement of the plan, performance metrics, could be implemented to properly portray the progress and accomplishments of research, especially basic research. The emerging consensus from the basic research sponsor and performer communities is that there exists a major mismatch between the stated requirements of GPRA and what is required to determine the health of a research program.

However, the GPRA legislation states that if "it is not feasible to express the performance goals for a particular program activity in an objective, quantifiable, and measureable form, the Director of the Office of Management and Budget may authorize an alternative form" [GPRA, 1993]. In a companion article in Science [Kostoff, 1997h], it is proposed that peer review be used as the dominant basic research program health diagnostic for GPRA, supplemented by bibliometric and other measures. There is a growing consensus in the larger research community that use of peer review is a more appropriate tool to measure basic research program performance in order to satisfy the GPRA requirements. If the GPRA oversight agencies agree with this philosophy, then the volume of research program peer reviews across the federal agencies will increase dramatically.

However, not only the volume of program peer reviews will change, but the conduct of the reviews will, of necessity, change. If GPRA is fundamentally a budgetary instrument [Brown, 1996], then the performance evaluation results which input to the performance budgeting process must be of the highest quality. The methods chosen to obtain these performance evaluation results, program peer review and the supplementary quantitative performance measures, would require more rigorous and standardized operational characteristics (Process selection, reviewer selection, etc.).

The purpose of the present section is to bring to the attention of the relevant research sponsoring, oversight, managing, and performing communities the underlying issues surrounding research program peer review. If these issues can be addressed comprehensively prior to full scale GPRA implementation, then procedures could be developed to conduct peer review in a manner which will not only support the performance budgeting process but could add value to the research program as well. To insure that the present section reflects the experiences and findings of the larger research evaluation community, principles and findings from the manuscript and proposal peer review literature will be utilized, where applicable, to illuminate the research program review issues and help bridge the gaps in the research program review literature.

There are three major components of the present section. The main body of the text (IV-A-1) addresses the underlying issues surrounding research program peer review. The next section (IV-A-2) summarizes research program peer review practices for selected federal agencies. The final section (IV-A-3) describes in detail a peer review process algorithm which embodies the best practices of federal agencies and many of the principles espoused in the main body of the present text. First, some definitions and background will be presented, to set the stage for the detailed examination of the peer review issues.

DEFINITIONS AND BACKGROUND

Research Program Definition

Fiscally, a research program is a collection of funded research components. These elements could be subprograms, projects, or individual work units (Principal Investigators-PIs). Conceptually, a program is greater than the sum of its components, just as the living human body is greater than the sum of its component molecules. A program includes the intelligence or inherent logic which links the components to each other and to the program's overall objectives, just as the living human body includes the intelligence which links the molecules to each other and to the homeostatic operation of the body. Thus, the intrinsic quality of a research program is not merely the sum of the qualities of the component projects, but depends on the quality of the structural relationships among the projects as well.

Review of a research program can then be viewed as consisting of two elements: 1) "review of a program of research", which examines the nature of the component projects, and is commonly referenced as an in-depth technical review, and 2) "review of a research program", which examines the nature of the structural relationships among the projects and between the projects and their external environment, and is commonly referenced as a management review. These two elements could be merged operationally into a single review, or could be performed separately.

A program could be single research discipline intra- or inter-agency; multiple discipline intra- or inter-agency; multiple discipline vertically integrated intra- or inter-agency; multiple discipline multi-agency multi-national; or other variants of the above. The nominal program discussed in this section is assumed to be intra-agency; the nominal review is assumed to be intra-agency. Some organizations review by disciplines, some organizations review by multi-discipline management unit, and in some organizations disciplines coincide with management units.

Peer Review Definition

The classical definition of a peer is "A person who has equal standing with another". A peer review, then, is a review of a person or persons by others of equal standing. The crucial issue then becomes how 'equal standing' is defined.

Most research peer reviews with which the author is familiar,

whether of journal research manuscripts, research proposals for funding, or research project performance reviews, tend to employ peer reviewers who are experts in the specific research area of the person or group under review. Depending on the relative levels of expertise between the reviewers and reviewees, the reviewers may or may not be de facto peers. Applied to research program review, such experts are most competent for the in-depth technical subset defined above as "review of a program of research". The focus of this subset is on the intrinsic nature of the collection of research projects within the program, especially on their quality, accomplishments, ongoing problems, unexpected findings and discoveries.

The focus of the management review subset defined above as "review of a research program" is on the structural relationships among the research projects within the program. This subset addresses issues such as mission relevance, budget adequacy, program staff, objectives, and procedures. To address the issues of this subset, additional types of peers to those of the first subset are required.

For the purposes of the present document, a more liberal interpretation of a peer than normally employed will be used to encompass the requirements for addressing both subsets of research program peer review. This expanded definition of a peer describes the types of reviewers that the author has tended to choose in conducting research program peer reviews which combine both subsets of program review into a single process. In this more inclusive definition, a peer may be a person expert in the specific technical area of the research being reviewed, in allied technical areas to the research being reviewed, in technology areas which may be impacted eventually by the research being reviewed, and in systems and operational areas which may be impacted in the future by the research being reviewed. These different types of peers are required to examine the different facets of a research program which could have impacts far beyond the specific research area being reviewed.

<u>Research Program Peer Review Background</u>

Research evaluation methodologies can be divided generically into three groupings [Kostoff, 1995c, 1996a]: Qualitative (e.g., peer review); Semi-Quantitative (e.g., retrospective); and Quantitative (e.g., bibliometric). Peer review of research is overwhelmingly the method of choice in practice in the U. S., as well as the rest of the world [Salasin, 1980; Logsdon, 1985; Chubin, 1990; Chubin, 1994; Kostoff, 1995a; Stamps, 1997a]. Presently, the major applications of research peer review are, in decreasing usage order: journal manuscript submission review; proposal review; project and program review; faculty performance review; and dissertation review.

Most of the peer review literature focus has been on manuscript and proposal review. For example, a 1993 literature survey [Speck, 1993] compiled 780 abstracts of papers on peer review, of which 643 papers were on journal peer review. According

to Armstrong [Armstrong, 1997], 101 of these provided empirical evidence. Relatively few studies have been done on the issues and principles underlying project or program review and reported in the open literature. This conclusion, complemented by Speck's and Armstrong's findings, was confirmed most graphically by a recent peer review literature survey conducted by the author. Over half the documents retrieved were either letters to the editors of journals, or editorials (or their equivalent). The papers on program review tended to be reports of technical and statistical results of the review, with little or no focus on the principles and issues underlying the peer review components. Whatever papers existed on peer review component principles related to manuscript reviews (mainly) or proposal reviews.

Peer reviews of research programs, when done at all, are not nearly as consistent across the research sponsoring organizations as are the manuscript and proposal reviews. Program reviews tend to range from very informal personal discussions to tens of formal panel reviews. Most of the people who conduct program reviews do not document them in the literature, and most of the principle and concept papers in the peer review literature are written by people who have never conducted a research program peer review. Consequently, there are two major gaps in the literature on research program peer review. First, there are quantitatively few papers published, and second, most of the concept and principle papers that do exist bear little relation to the reality of conducting a program review.

To identify and address some of these gaps, a number of peer review issues will be examined now. These issues were selected from a taxonomy of categories generated by the author's recent peer review literature survey, as well as from previous assessments of problems with peer review and other research evaluation approaches [Kostoff, 1996a]. The headings of the topical issues addressed in the main body of this text immediately following this section include: Objectives and Purposes of Peer Review; Quality of Peer Review; Impact of Peer Review Manager on Quality; Selection of Peer Reviewers; Selection of Evaluation Criteria; Secrecy (Reviewer and Performer Anonymity); Objectivity/ Bias/ Fairness of Peer Review; Normalization of Peer Review Panels; Repeatability/ Reliability of Peer Review; Effectiveness/ Predictability of Peer Review; Costs of Performing a Peer Review; Ethical Issues in Peer Review; Alternatives to Peer Review; Recommendations for Further Research in Peer Review.

IV-A-2. PEER REVIEW PRINCIPLES

OBJECTIVES/ PURPOSE OF PEER REVIEW

Peer review supports many diverse purposes. It serves as a quality filter to conserve resources: papers published in peer-reviewed journals are assumed to be above a minimal quality threshold, such that the reader can focus limited time resources on the highest quality documents assumed to be contained in these

journals; projects and programs selected for initiation or continuation by peer review are assumed to be above a minimal quality threshold, and precious labor and hardware resources can be focused on these high quality tasks selected. Peer review has the potential to add value to, and improve the quality of, the manuscript or program under review. Peer review can provide an imprimatur of legitimacy and competency to increase a program's visibility and support. The objectives of peer review range from being an efficient resource allocation mechanism to a credible predictor of research impact. A properly conducted research program peer review can provide credible indication to the research sponsors of program quality, program relevance, management quality, and appropriateness of direction [Alassaf, 1996; Armstrong, 1997; Cram, 1992; Gabel, 1992; GERMANY, 1988; Kessler, 1992; Levine, 1988; Palli, 1993; Rainville, 1991; Ramsay, 1989; Stull, 1989; Wakefield, 1995; Wicks, 1992].

The literature contains some quantitative studies which indicate some value added by peer review. For example, recent studies evaluated the effects of peer review and editing on manuscript quality [Goodman, 1994], and the effects of peer review and editorial processes on the readability of original articles [Roberts, 1994]. They concluded that peer review and editing improve the quality of medical research reporting, as well as the readability of original articles and their abstracts. They did not address whether the quality of the research was improved, nor do other literature articles.

From the author's experience, there are three times during the research program peer review process when value is added. First is the period between reviews, when the researchers do their work knowing that it will be subject to high quality review. The value added during this performance phase is that the researchers will maintain a higher level of performance quality because of the knowledge of the forthcoming expert review. For example, performers will be less inclined to work on their theses for decades if they know that they will be evaluated periodically. Program managers will be more likely to continually update the balance and relationships among their component projects, rather than allow poor performers to languish, if they know that a review is forthcoming.

The analogy is to a well-known speed trap on a highway. The knowledge that a stretch of road is well policed is sufficient to keep the average speed within the posted limit. The fact that the officers write relatively few tickets in this area is not a measure of effectiveness of the speed trap. It would be useful if studies were done comparing the quality of research of periodically reviewed programs to infrequently ad hoc reviewed programs to see if this value added component is experimentally verifiable.

Second is the period of review preparation, particularly the 'dry runs' for program presentations. This is an extremely valuable experience, both for the managers and the researchers, and would by itself justify the cost and effort of the total review. Especially for research program peer review, the preparation period

provides a focal point for discussion of unresolved issues and priorities, and fuels substantive discussions in order to arrive at a quality presentation. The value added is not in the superficial presentation form improvement, but in the substantive increase in the intrinsic program quality.

Third is the actual review. Here, independent viewpoints are injected in a public forum, high quality research is re-affirmed, and strong recommendations are provided for the fate of poor research.

A fourth time of value added could be postulated as well, depending on the review results. If the review outcome was very favorable, and eventually resulted in additional program funding, then value was added, at least to the funding recipients and hopefully to the larger society as well.

Finally, it should be remembered that any of the review processes involve real-time <u>judgements</u> of the quality of research, not expressions of the intrinsic quality of the research. The passage of time is required to follow the evolution of research to ascertain whether it achieves its promise. How well these peer review judgements relate to the actual impact of the research on science and technology and society is an important measure of long-term peer review value, and is addressed to some extent in the later section on Predictability.

Another taxonomy of the potential values added by peer review can be summarized as [Chubin, 1994]:

1. an effective resource allocation mechanism;
2. an efficient resource allocator;
3. a promoter of science accountability;
4. a mechanism for policymakers to direct scientific effort;
5. a rational process;
6. a fair process;
7. a valid and reliable measure of scientific performance.

Much of the remainder of the main body of this section examines the intrinsic and arbitrary roadblocks to achieving these desirable goals in a research program peer review. Many of the negative aspects of program peer review will be addressed, such as potential bias, cost, and protection of the status quo. The present sub-section concludes by examining briefly another potentially negative aspect of peer review not addressed by the literature; namely, whether the knowledge of periodically scheduled reviews would stifle the pursuit and presentation of very innovative but far-out ideas. Would performers be reluctant to present these ideas in a public forum, where the credibility of the performers could be challenged for these ideas? In other words, does the practice of peer review, and especially panel-based program peer review, effectively result in <u>self-censorship</u> of radical ideas? This is an area where research is needed to ascertain whether ideas have been suppressed in periodically reviewed programs, and then to determine how this problem could be surmounted if it exists.

QUALITY OF PEER REVIEW

The studies related to peer review which have been reported in the literature range from the mechanics of conducting a peer review, to examples of peer reviews, to detailed critiques of peer reviews and the process itself. In addition to descriptions of peer reviews and processes contained in the reviews and surveys referenced above, other examples of processes and critiques can be found in [Armstrong, 1997; Chubin, 1990; Chubin, 1994; Barker, 1992; Cicchetti, 1991; Cole, 1981; DOE, 1993; Frazier, 1987; Kostoff, 1995d].

While the reported studies of peer reviews present the process mechanics, the procedures followed, and the review results, the reader cannot ascertain the <u>quality</u> of the findings and recommendations of the review. In practice, procedure and process quality are mildly necessary, but nowhere sufficient, conditions for generating a high quality peer review. Many useful peer reviews have been conducted using a broad variety of processes, and while well documented modern processes (e.g., [DOE, 1993]) may contribute to the efficiency of conducting a review, more than process is needed for high quality. Many intangible factors enter into a high quality review [Evans, 1990; Friedman, 1995; Goodman, 1994; Lundberg, 1991; Luukonnen-Grunow, 1990; McNutt, 1990; Vandenbroucke, 1994], and some of the more important factors will be discussed.

The underlying hypothetical postulate of this section is that there exists an intrinsic quality inherent in every basic research task. By definition, a high quality peer review should provide an accurate picture of this intrinsic quality of the research being reviewed, irrespective of whether this intrinsic quality is high or low. The fundamental problem is that there are no absolute standards for the measurement of research quality, analogous to physical standards for primary measurements such as time and length. Presently, evaluation of intrinsic research quality is a subjective process, depending on the perspectives and past experiences of the reviewers. A high quality review under these imperfect circumstances, then, would be defined to occur when two generic conditions are fulfilled: 1) utilization of highly competent reviewers, and 2) no injection of additional distortions in the reviewers' evaluations as a result of biases, conflict, fraud, or insufficient work.

High quality peer review processes require as a minimum the conditions summarized from Ormala [Ormala, 1989]:

1. The method, organization and criteria for an evaluation should be chosen and adjusted to the particular evaluation situation;
2. Different evaluation levels require different evaluation methods;
3. Program and project goals are an important consideration when an evaluation study is carried out;
4. The basic motive behind an evaluation and the relationships

between an evaluation and decision making should be openly communicated to all the parties involved;

5. The aims of an evaluation should be explicitly formulated;

6. The credibility of an evaluation should always be carefully established;

7. The prerequisites for the effective utilization of evaluation results should be taken into consideration in evaluation design.

The impact of a peer review on decisionmaking is considered as a measure of its effectiveness, not its quality. Poorly conducted peer reviews could theoretically have major influences on decisions, and well conducted peer reviews could have minimal influence on decisionmaking. It is important to separate peer review quality from effectiveness.

A corollary aspect of peer review quality, although in the author's judgement not a primary contributor to nominal research program peer review quality, is the commission of errors by the reviewers. The author is not aware of published studies which have examined the commission of errors by research program peer reviewers. In a recent paper [Armstrong, 1997], different studies of errors and superficial work by peer reviewers of journal manuscripts are described. The conclusion one draws from these results is that the problem of manuscript reviewer error production is not insignificant. Armstrong does make the point that journal manuscript peer reviewers typically receive no extrinsic awards, are typically anonymous, and therefore in some cases may not feel motivated to exert the effort required for a high quality review.

There is somewhat of an imbalance in this author-reviewer symbiosis, since the journal article author spends hundreds of hours performing the work and is required to place his reputation on the line when submitting the article for publication, while the reviewer spends relatively few hours at his task with essentially little chance of damage to his reputation for mediocre performance. The legal system recognizes the existence of these human frailties, and has a multi-level hierarchical appeals system established to handle possible errors by judges and juries. The medical/ legal system also has effectively an appeals procedure established by its malpractice system. Perhaps the science profession needs the establishment of a somewhat more formal appeals system to level the playing field for manuscript authors and others subject to peer review, and to insure that in the end justice will be served and quality will be maintained. A recent paper [Stamps, 1997b] reviews the literature on conflict resolution, and describes a process (dialectical scientific brief) for resolving disputes from manuscript peer review in scientific journals. This, or some alternative, procedure could be modified to apply to other types of scientific peer review as well.

In most research program peer reviews, commission of technical errors by reviewers due to the relaxed standards resulting from anonymity and lack of financial incentives is probably not nearly as serious as in manuscript reviews. While a small fraction of

program reviews may be carried out by anonymous mail reviews from experts (if this is done at all, it would apply when the program is evaluated by reviewing each of the projects separately), the vast majority of program reviews are carried out with the use of expert panels. In some cases, the panel members may receive modest compensation, but in any case, they are no longer anonymous. Their reputations are on the line as they participate in these panels. In the author's experience, panel members tend to suppress overt expressions of biases, and they typically make statements they are able to defend. Whether this translates into more conservatism relative to the anonymous journal manuscript reviews depends on how the review process is structured, and is discussed in more detail later in the section on Secrecy. In any case, studies of the extent of errors committed by research program peer reviewers remain to be done, and if these panels eventually have substantial input to the budgetary process, then some sort of appeals system for program reviews may have to be established.

IMPACT OF PEER REVIEW MANAGER ON QUALITY

From the author's perspective, the single most important factor in producing a high quality research program peer review is the dedication of an organization's senior management to the highest quality objective review, and the associated emplacement of rewards and incentives to encourage such reviews. The second most important factor in producing a high quality review, and in fact the cornerstone of a successful review, is the motivation of the person managing the review to conduct a technically credible review. This review leader selects and manages the review process, selects the review criteria, selects the reviewers, guides the questions and discussions in a panel review, summarizes the reviewers' comments in a mail or panel review, and makes recommendations about whether a program should be initiated, continued, or modified.

The direction of the assessment may be heavily influenced if conscious or subconscious biases of the review leader are exerted, especially during the reviewer selection process. In an extreme case of bias, the review's results could be determined completely by the reviewer selection before the reviewers ever meet. This conclusion is valid for the manager of a program or project review, the manager of a proposal review, or the editor in charge of a journal manuscript review. The author is not aware of any of these types of reviews where the reviewers are selected by a random process, which would eliminate much of the selection bias. Because of this potential intrinsic bias due to the conscious reviewer selection by the review manager, unless random reviewer selection is operable in conducting a review, any mathematical correlations [e.g., Cicchetti, 1991] between reviewers' scores and review outcomes (illuminating and insightful though they may be) must be opened to question.

SELECTION OF PEER REVIEWERS

Even with the strongest support from an organization's top management, and the direction of an unbiased and competent review leader, the quality of a review will never go beyond the competence of the reviewers. Two dimensions of competence which should be considered for a research review are the individual reviewer's technical competence for the subject area, and the competence of the review group as a body to cover the different facets of research issues (other research impacts, technology and mission considerations and impacts, infrastructure, political and social impacts) [Kostoff, 1995d, 1996a; Garson, 1980; Klahr, 1985; Marshall, 1996]. The quality of a review is limited by the biases and conflicts of the reviewers. The biases and conflicts of the reviewers selected should be known to the leader and to each other.

One common error in panel selection is limiting the choice of research experts to those who have specific expertise in the subdisciplines of the existing program. This provides an answer to the question of whether the <u>job is being done right</u>, but not to whether the <u>right job is being done</u>. The former question relates to detailed technical quality, while the latter question relates more to investment strategy in the broadest sense (investment strategy is the rationale for the prioritization and allocation of resources among the program components). To answer the latter question, people with broad expertise in the area covered by the overall program's highest level objectives should also be selected. They would be able to address the investment strategy more objectively, and determine whether the mix of subdisciplines, and the allocation of resources among the subdisciplines, is appropriate. The review group, then, would be able to address the central question of whether the <u>right job is being done right</u>.

One of the major criticisms of peer review, whether manuscript, proposal, or program, is that it tends to perpetuate orthodox and conservative paradigms, and tends to reject new paradigms which threaten the structure of the status quo. If one of the objectives of a research program peer review is in fact to ensure that innovation is recognized, that truly revolutionary research with attendent new paradigms will be promoted and rewarded, then this selection of reviewers to address the <u>right job</u> issue in parallel with reviewers to address the <u>job right</u> issue becomes of paramount importance.

One of the most severe deficiencies of many present research program peer reviews is the concentration of panel experts on the issue of doing the <u>job right</u> and the effective absence of experts on doing the <u>right job</u>. This can lead to the situation which the author has termed "The Pied Piper Effect" [Kostoff, 1997b]. This phenomenon was defined initially for the specific case of interpretation of journal paper citations, but it is applicable to <u>any</u> conclusion resulting from <u>any</u> type of peer review as well: journal, proposal, program. Its initial bibliometric definition, and then extrapolation to program peer review, follows.

One of the main concerns with using citations as a stand-alone measure of quality and impact has been the potential bimodal interpretation of the numerical results. A paper could receive

high citations because of its high quality, or because the citers disagree with it. However, there is a third interpretation which may be the most insidious, and further precludes citations being utilized in stand-alone mode, the "Pied Piper" effect.

Assume there is a present-day mainstream approach in a specific field of research; for example, the chemical/ radiation/ surgical approach to treating cancer (See [Kostoff, 1997b] for a more detailed example of the "Pied Piper Effect"). Assume the following hypothetical scenario: there exist alternative approaches to treatment not supported by the mainstream community; in fifty years a cure for cancer is discovered; the curative approach has nothing to do with today's mainstream research, but is perhaps a downstream derivative of today's alternative methods; it turns out that today's mainstream approach sanctioned by the mainstream medical community was completely orthogonal or even antithetical to the curative approach. Then what meaning can be ascribed to research papers in cancer today which are highly cited for supposedly positive reasons?

In this case, a paper's high citations are a measure of the extent to which the paper's author has persuaded the research community that the research direction contained in his paper is the correct one, and not a measure of the intrinsic correctness of the research direction. It is analogous to firing a missile accurately at the wrong target. In fact, the high citations may reflect the deliberate desire of a closed research community (the author and the citers) to persuade a larger community (which could include politicians and other resource allocators) that the research direction is the correct one.

This is the "Pied Piper" effect. The large number of citations in the above hypothetical medical example becomes a measure of the extent of the problem, the extent of the diversion from the correct path, not the extent of progress toward the solution. The "Pied Piper" effect is a key reason why, especially in the case of revolutionary research, citations and other quantitative measures must be part of and subordinate to a broadly constituted peer review in any credible evaluation and assessment of research impact and quality.

The extrapolation of the "Pied Piper Effect" to research program peer review becomes obvious. Many technical communities are comfortable with the status quo, have large personal and infrastructure investments in the mainline orthodox approaches, and feel threatened by new paradigms which could render their investments obsolete. If the peer reviewers represent only the community of the specific research approach being reviewed, then the debate will typically center around the correctness of the miniscule details of the approach (job right) rather than whether the approach should be used at all (right job). The net effect of such a limited review is to provide a stamp of approval (analogous to the high citation rates described above) to continuance of the mainline approach, and to close the door to revolutionary thinking.

Attachment 6 describes a method for selecting peer reviewers which approximates the best practices in use today. While it is

not a pure random selection process, it does remove much of the bias of present selection practices, and would be appropriate for the large scale program peer reviews discussed here.

SELECTION OF EVALUATION CRITERIA

Research evaluation criteria are one instrument through which an organization promulgates strategic and policy research objectives. Detailed responses to the criteria by reviewers are valuable as inputs for downstream decisionmaking. When documented, review criteria also serve as tangible indicators to external groups that strategic objectives are being implemented [Delcomyn, 1991; Eibeck, 1996; Kellie, 1991; Martin, 1981; Sutherland, 1993; Weinberg, 1964, 1989].

Individual criteria can be viewed mathematically as the components of a vector. The complete vector, or figure of merit of the review, can then be constructed as the weighted sum of the scores of its components. For example, assume two criteria, Research Merit (RM) and Mission Relevance (MR), are generated by the evaluating organization to be used by reviewers for research program evaluation. Assume each criterion is weighted equally by the evaluating organization. Then, in the absence of further constraints, the final figure of merit, overall program quality (OPQ), is computed as OPQ=.5*RM+.5*MR.

Problems arise, however, because the stated criteria are seldom the only criteria considered important by the reviewers. In the case above, the evaluating organization selected only two criteria which it feels are important and which it wants the reviewers to address. It also selected the weighting to be assigned to each criterion, and the figure of merit algorithm. Conflict arises because each reviewer has his or her own view of what criteria are important for evaluating research, how these criteria should be weighted for a particular program, and how they should be integrated for a final figure of merit. In the author's experience covering hundreds of different types of peer reviews, evaluators actually conceive a <u>gestalt</u>, or view of the integrated nature, of the total reseach package when performing the evaluation. The component criteria serve to stimulate reviewers' thinking in specific areas, and insure that the reviewers include issues deemed critical to the review managers.

In the example case, there is the potential for serious mismatch between the final figure of merit vector obtained by the organization's algorithm and by the reviewers' mental algorithm. The two vectors could be sufficiently different that one could completely misrepresent the other. For example, assume the organization provided the algorithm above to the reviewers, and also assume that the definition of Research Merit (importance of the problem to science) did not include Research Approach (approach taken to solve the problem). Assume the reviewers felt that the RM and MR were high quality for a program being reviewed. However, assume that the reviewers felt the Research Approach taken was extremely poor in the program under review, and that Research

Approach was the most important criterion in deciding the overall value of this particular research program. In this case, use of the organization's criteria and algorithm will provide a conclusion orthogonal to that desired by the reviewers. Even if the organization provides the additional flexibility of allowing the reviewers to provide their own weighting to the criteria, in the example shown the reviewers' desired conclusion will still be orthogonal to that obtained using the organization's algorithm with criteria of arbitrary weighting.

The author has found that expert reviewers are usually individuals of integrity, and the way they resolve the above dilemma is through the principle of compromise rather than the compromise of principles. Operationally, the reviewers develop an intuitive judgement of the worth of the total research package under review, then 'reverse-engineer' the weighting and scoring of the criteria sub-consciously (if not consciously) until the evaluation algorithm comes closest to their desired intuitive overall result.

Based on these observations, the author recommends (and uses) inclusion of an overall project/program quality criterion as well. This 'bottom-line' score makes clear the reviewers' judgements about the total research package presented, and incorporates the effects of any unstated criteria (e.g., organizational appropriateness) which a reviewer feels are important determinants of overall research quality. This approach reduces the necessity for 'reverse engineering' to arrive at displaying the reviewers' deepest convictions. If the evaluating organization still wants to use only its own criteria to arrive at the final figure of merit, then, by comparing the reviewers' vector and the organizational algorithmic vector, the organization can identify the trade-off in reviewer-perceived quality which resulted from ignoring reviewer-relevant criteria.

The later section in this paper on agency peer review practices discusses the more detailed studies performed by the author and others on selection and importance of research program evaluation criteria. In general, these studies show that the most influential criteria relative to a reviewer's final evaluation rating are research merit, research approach, and performer quality. In addition, a relevance criterion is important in mission agencies. Nearer-term relevance, such as transition to technology (or utility), tends to be more influential on a reviewer's final overall rating than longer-term relevance to the sponsor's downstream mission. Finally, as stated above, inclusion of a single 'bottom-line' criterion is crucial.

SECRECY: REVIEWER AND PERFORMER ANONYMITY

The issue of reviewer anonymity was discussed briefly in the section on Quality, with the conclusion that detailed technical quality of the reviewer's product was not helped by the anonymity. From the author's viewpoint, this negative aspect pales compared to the benefits resulting from reviewer anonymity, although there is

not a unanimity of opinion on this conclusion in the literature [Altura, 1990; Berezin, 1994; Clayson, 1995; Debakey, 1990; Frei, 1993; Gresty, 1995; Knox, 1981; Neetens, 1995].

What is really desired from a peer reviewer is an honest viewpoint on the intrinsic quality of research under review, supported by rigorous technical analysis where possible. Having the reviewer and reviewee present during the review (and this applies to manuscript, proposal, and program review; 'present' just must be interpreted differently in each case) will sharpen the quality of the technical discussion details, and eliminate many of the types of errors reported in the studies [Armstrong, 1997] discussed earlier in the Quality section.

However, having the reviewer and reviewee present during the review will, in many cases, obviate the expression of the reviewer's deepest convictions about the quality of the research. Rewards are few for making strong negative statements about a research paper, proposal, or program, and resulting retributions and resentments may far outweigh the intrinsic benefits of honest and forthright judgement statements. In a research program peer review in particular, the situation is more complex than a manuscript peer review. In program review, it is the program manager who, in a real sense, is being reviewed, as well as the research. If the reviewers are 'bench-level' experts in the field of the manager's research program, as one assumes they typically are, and at some point in the future would have an interest in participating in the manager's specific research program, then forthright but negative reviews could have potentially serious consequences on their ability to obtain future funding from the program manager. Finding true peers to serve as research program reviewers in this case may be extremely difficult, and requires judicious care in the selection process.

The author has conducted program/ proposal reviews which span the gamut from complete reviewer anonymity to complete reviewer presence with reviewee and audience. In the author's experience, there is a hierarchy of levels of reviewer anonymity which produce different degrees of frankness and honesty in the reviewer's response.

The most honest and straightforward reviewer's opinions result from phone reviews where the reviewer is completely anonymous to the reviewee. In this case, the reviewer has been provided information about the research (typically written) and provides feedback orally over the phone. The frankness of response is most evident in evaluating the <u>right job</u> function, where the integrity of the total research approach is at stake. Reviewers are less reluctant to be more open when critiquing the <u>job right</u> function, since major direction and infrastructure changes will not be at risk, and the reviewee's defenses will not be as vociferous.

Next in the hierarchy are written reviews where the reviewer is completely anonymous to the reviewee. Some reviewers will tend to moderate the frankness of their comments when asked to provide them in writing. However, if the reviewers trust the review manager to protect their anonymity, they will still be quite frank

in their writeups.

The next level of anonymity occurs when the reviewers and reviewees are both present during the research presentations, but the reviewers meet in closed session to provide oral and written evaluations of the research, with these evaluations not for attribution. Even the presence of the anonymity during the closed session will provide much frank discussion and exchange of heartfelt opinion.

The final level is the absence of anonymity, where both reviewers and reviewees are present throughout the total process, and all verbal and written comments are provided with full attribution. While it may be argued that this type of review is better than having no review, from the author's experience this approach does not begin to utilize the full potential of what expert peer review can offer.

The other side of the secrecy coin is witholding the reviewee's name and affiliation from the reviewer. This process has been termed "blind reviewing" [Blank, 1991; Ceci, 1984; Cox, 1993; Evans, 1990; Fisher, 1994; Johnson, 1995; Laband, 1994; McNutt, 1990; Nylenna, 1994; Rosenblatt, 1980; Shaughnessy, 1988; Sly, 1990]. Its objectives are to provide fairer reviews of work by unknown researchers or by researchers from less prestigious institutions [Armstrong, 1997], or conceiveably to eliminate bias based on personal characteristics such as gender. Blind reviewing (and its corollary "double-blind" reviewing, when both the reviewer and reviewee are anonymous to each other) is probably most applicable to manuscript review. Some studies of blind reviewing for journal manuscripts have been reported [Fletcher and Fletcher, 1997; Fisher, 1994; Laband, 1994]. Reviews by blinded reviewers were judged by the editors to have higher quality; the blinded reviewers gave better scores to authors with more previous articles, and articles published in journals using blinded peer review were cited significantly more than articles published in journals using non-blinded peer review.

Unfortunately, removing the identity of the reviewee from the research under review is akin to solving an equation after eliminating the dominant term. The DOE peer review study of the quality of its Office of Basic Energy Sciences' research program [DOE, 1982], which is probably the classic study of research program quality using a statistical sampling of component project quality, concluded that team quality was the most important variable in determining overall project quality. Based on these, and other similar results, evaluating proposals without reviewee identity could provide misleading results. There are many good proposed research topics in existence. The high quality researcher will develop a track record of not only addressing good research topics, but through perseverance and critical thought will make substantial progress toward solutions. Today, there exist many consulting firms that will assist researchers in preparing funding proposals. These consultants are very aware of the appropriate 'buzzwords' and politically correct terminology, and what type of formatting and proposal organizational structure will appeal most

to decision makers. Judging such proposals independent of the researcher will eventually allow form to predominate over substance.

In any case, blind reviews probably have minimal applicability to research program reviews. In most cases, panel reviews are used, and extraordinary precautions would have to be taken to protect the identity of the reviewees. Coupled with the inability to use the team quality criterion, there appears to be little motivation to employ this process in program peer review. There appears to be nothing on this topic related to program review in the literature.

OBJECTIVITY/ BIAS/ FAIRNESS OF PEER REVIEW

Probably the most criticized aspect of all types of peer review is the role of bias, and its subsequent impact on fairness, in the final recommendations of the reviewers. Peer reviews have received written and verbal accusations of having gender bias, race bias, institutional bias, geographic bias, age bias, and especially a conservative bias toward protecting the 'old boy's' network of the status quo. Much research effort has been focused on this issue of bias and fairness [Armstrong, 1982, 1997; Bailar, 1991; Daniel, 1993; Ehlen, 1996; Ernst, 1994; Ramasarma, 1995; Spitzer, 1994]; Armstrong [Armstrong, 1997] makes the point that almost half of the empirical papers on journal reviewing in a recent massive study [Speck, 1993] address these issues.

The findings are mixed. A recent study [Gilbert, 1994] assessed whether manuscripts received by the JAMA possessed differing peer review and manuscript processing characteristics, or had a variable chance of acceptance, associated with the gender of the participants in the peer review process. The study concluded that gender differences exist in editor and reviewer characteristics at JAMA with no apparent effect on the final outcome of the peer review process or acceptance for publication.

Another study [Peters, 1982] found that reviewers were biased against authors from unknown or less-prestigious institutions. A study in which NSF proposal reviews were re-evaluated by a different panel [Cole, 1981] included institutional reputation, professional age, academic rank, geographic location, and other variables. It concluded that the peer review system employed by NSF was essentially free of systematic bias. A study of the DOE Office of Basic Energy Sciences [DOE, 1982] stated that the conclusions concerning the laboratory and non-laboratory projects were not distorted by reviewer biases.

A 1992 report elaborates on the concerns of bias and conflict in a section describing guidelines on a common framework for organizing Federal investments [NAS, 1992]. Its Principle 6 (Program Evaluation) contains the statement: "Current efforts to review government R&D programs have suffered, in some instances, from the fact that annual reports to Congress or the executive branch have been conducted by mission agency employees with a direct interest in having projects they evaluate continue. Technical evaluations of the R&D work and of the contributions to

national economic welfare of pre-commercial R&D programs should be conducted by nongovernmental groups that do not have a direct role in program management or funding decisions".

The underlying paradigm of the bias/ fairness issue is that all reviewees should be treated the same; there should be a level playing field for all players. Unfortunately, in the implementation of this noble philosophy, the rules of scientific evidence take second priority to the rules of political correctness. This motivation toward perceived increased fairness is probably the main driver for peer review concepts such as 'blind reviewing', which was addressed in the previous section of this paper on Secrecy. It was concluded that the downside to "blind reviewing" was the elimination of the key reviewer criterion of track record (team quality) and the subsequent degradation of the review process quality.

However, assigning overwhelming importance to track record, as proposed by some researchers in the later Alternatives section of this paper, shifts the functional balance toward emphasizing the job right aspect of the research as opposed to the right job aspect, and is in many respects a double-edged sword. It presents serious obstacles for young researchers with little track record who may have very good ideas for solving difficult research problems and may be very capable of addressing these problems, and has the potential for maintaining the 'old boy's' network and the status quo. This can have very serious consequences, as the discussion of the "Pied Piper Effect" showed in the previous section. The solution to this paradox is not to eliminate the key variable of researcher identity, but rather to select reviewers such that the perspective of the panel is broadened. Use panelists who are able to address the right job aspects of the research target, to insure that outmoded but prolific and well-cited research is not promulgated in perpetuity, and that the pool of expertise is being continually refilled.

NORMALIZATION OF PEER REVIEW PANELS

Peer review is a diagnostic process which can be applied in isolation on a body of research, or can be used for comparing many different types of research. When applied for comparative purposes, a key issue centers around how the results of different panels evaluating different technical disciplines can be normalized such that comparisons across disciplines and panels become meaningful. How, for example, can the differences in intrinsic quality of the different types of research being reviewed be separated from different panel biases, different panel interpretations of criteria, different severities of panelists in applying the criteria, when only scores and comments which include all these factors are presented. This normalization issue is perhaps the most difficult aspect of peer review, and normalization difficulty also applies to other aspects of research evaluation such as bibliometrics [Braun, 1982; Kostoff, 1997m; Schubert, 1996].

Most studies which examine peer reviews across disciplines present the results for the major discipline categories separately [e.g., DOE, 1982; Cicchetti, 1991; Cole, 1981]. They essentially finesse the problem. While this separation of categories is valid when research is viewed from a strategic viewpoint, where disciplines are selected and maintained for their importance to an organization's mission, this discipline separation reduces the value of peer review as a quality comparative yardstick considerably. Quantitative evaluation approaches, such as bibliometrics, develop reference standards for different disciplines and then construct appropriate scaling procedures for ranking the research [Schubert, 1996]. This does allow for comparison of relative rankings across disciplines in a broad generic sense, but questions arise as to the applicability of reference standards defined for a discipline (e.g., acoustics) to programs being compared within the discipline (e.g., underwater acoustics vs aeroacoustics).

The author has not seen any fully satisfactory peer review normalization approaches due to the presence of the many variables listed previously. However, one interesting normalization approach is used by the Dutch STW for evaluating research proposals [Van den Beemt, 1991, 1997]. Technical comments, but not quality ratings, are provided by technical peers. The comments, and proposer responses, for twenty different proposals are then provided to twelve people from a variety of disciplines. This 'jury' of twelve provides the scores through an independent mail review. Essentially, the normalization is provided by having the twelve jurors common to all proposals.

The author has used two approaches to improve normalization across panels somewhat. First is the utilization of some individuals common to all panels. In a series of competitions for new accelerated research programs that was held in the late 1980s [Kostoff, 1988], the author served as chairman of all the different discipline panels. This resulted in some small measure of normalization among the different panels. Use of more individuals common to all panels would have provided an extra measure of normalization, and in this sense the presence of senior management during the reviews provided additional measures of normalization. Obviously, the more closely the panels are related topically, the more valuable is the technical contribution of individuals common to the different panels.

Second, it was assumed that the difference in aggregated average scores for major disciplines (e.g., physical sciences and life sciences) was due to two factors: differences in intrinsic quality of the programs proposed and differences in the scoring severity of the reviewers. To normalize, a fraction of the differences in aggregated average scores for the major disciplines was removed. This was assumed to eliminate the scoring severity difference. Trial and error showed a fifty percent correction factor provided results which appeared intuitively reasonable to the relevant audience members who had attended all the reviews. This normalization procedure had the added benefit of preserving

and insuring representation from disciplines which had strategic value to the organization.

This approach to normalization could have a second interpretation. If the research is viewed as having a strategic component and a quality component, with the reviewers' scores viewed as addressing the quality component only, then the correction could be perceived as adjusting for the presence of the strategic component. For example, assume a Life Sciences panel produced an average program score of five, and an Engineering Sciences panel produced an average score of ten. Assume further that each discipline had equal strategic value to the organization, and that the strategic value was of equal importance to the reviewers' scores (assumed to be a total program quality score which includes mission relevance). Then the normalized total score can be computed as FOM = 0.5*STRAT + 0.5*SCORE, and the difference between the two panels' scores would be reduced from five to 2.5.

If peer review is eventually used to support GPRA, then some sort of normalization procedure will be required for credibility. Given the very limited validity of existing schemes for normalization, especially across disparate disciplines, this will be difficult. If GPRA is used to affect research budgets, valid procedures to normalize scores will be essential, and they do not exist now. This is a very fertile area for peer review research.

REPEATABILITY/ RELIABILITY OF PEER REVIEW

In a physical system experiment, one of the main questions asked to gauge credibility of the results concerns the repeatability of the results. Can the same experiment be run at different laboratories under the same controlled conditions and yield the same results, or some reasonable facsimile thereof? The analogous issue in peer review has been termed alternatively reliability, repeatability, consistency, uniformity, etc., and has received much focus in the literature [Bailar, 1991; Ceci, 1982; Cicchetti, 1976, 1979, 1991; Cole, 1991; Colman, 1991; Crothers, 1993; Daniel, 1993; Gorman, 1991; Halpin, 1986; Kiesler, 1991; Kraemer, 1991; Laming, 1991; Luce, 1993; Marsh, 1989; Roediger, 1991; Rosenthal, 1990, 1991, Rubin, 1992]. The meaning is the same.

There are two corollary concepts in physical systems which unfortunately are not always carried over to peer reviews. These are the concepts of precision and accuracy. Precision represents the degree to which a measurement value can be replicated, while accuracy represents the relation of the measurement value to some absolute value or standard.

In a very comprehensive study of the reliability of peer review for manuscripts and grant proposals [Cicchetti, 1991], which included hundreds of references, reliability was defined generically by different measures: internal consistency, interreferee agreement (degree of agreement among referees), and stability across time. Reliability by these definitions appears to be the analog of precision as defined above, and the issue of

accuracy does not appear to enter the definition. The study stated that the most common measure is interreferee agreement at a given point in time. The study essentially concluded that, across the various science disciplines examined: 1) agreement is better on manuscript and grant submissions of perceived poor quality than on submissions of good quality; 2) better defined (specific and specialized) areas of scientific inquiry have higher acceptance rates and use fewer reviewers than less well-defined (general and less focused) areas of scientific interest; and 3) levels of chance-corrected interreferee agreement are rather low.

However, neither the study commentary nor the descriptions of the referenced studies addressed the issue of truly random reviewer selection, and therefore the meaning of the study conclusions is open to question. For example, what is the meaning of high reliability under these conditions. It could mean that the reviewers were able to identify and report accurately on the intrinsic quality of the manuscript/ proposal, or it could mean that the reviewers were selected because of their extreme bias (positive or negative) toward the topic and the review manager did an outstanding job of selecting reviewers with similar biases.

In addition, there is a school of thought that chance-corrected interreferee agreement should in fact be low, because the astute manager will pick reviewers who have sharply different viewpoints and expertise, so that they should be sensitive to different kinds of problems. From this perspective, too much agreement may be a sign of weakness, that the system is not eliciting the full spectrum of opinion that the manager needs to make an informed decision.

A study of National Science Foundation (NSF) proposals [Cole, 1981], funded by NSF, using two sets of reviewers, showed a reversal rate (one group's decision would have been reversed by the other group) of about twenty-five percent. Since an entirely random process would have produced a reversal rate of fifty percent, it was concluded that the fate of a particular grant application is roughly half determined by the characteristics of the proposal and the principal investigator, and about half by apparently random elements. It was also concluded that the great bulk of reviewer disagreement observed is probably a result of real and legitimate differences of opinion among experts about what good science is or should be.

Similar reliability studies of research program reviews do not appear to be in the literature, probably because of the expense and effort of doing the replication involved in such studies, especially for panel reviews, and the question of whether the identical process is actually being replicated. The author's experience with reviews of existing and proposed research programs, a small fraction of which was documented and analyzed mathematically [Kostoff, 1992a], is that reliability is sufficient for practical purposes. While a peer review can gain consensus on the proposed and existing reseach programs that are either outstanding or poor, there will be differences of opinion on the programs that cover the much wider middle range. For programs in

this middle range, their fate is somewhat more sensitive to the reviewers selected. If a key purpose of a peer review is to insure that the outstanding programs are funded or continued, and the poor programs are either terminated or modified strongly, then the capabilities of the peer review instrument are well matched to its requirements.

The author's experience with the reliability of program peer reviews appears to be somewhat less negative than those above, or other similar studies reported in the literature. Why is this? It probably is due in large measure to how the peer review is conducted. In many proposal and manuscript reviews reported in the literature, there tends to be minimal feedback among the reviewers, and between the reviewers and authors/ proposers. Probably at best there is one written rebuttal. This independence is undoubtedly valued, and is also less expensive than convening all the players to interact jointly.

The author's peer reviews involve extensive interaction among the reviewers and presenters. Many misunderstandings and differences in interpretation are clarified during the exchange of technical information before the scoring is performed. The initial scoring is performed independently by the reviewers. Then, differences in scores are discussed, and the reviewers are provided the opportunity to modify their scores. Usually, the final scores become closer. From the author's observations, this scoring variance reduction is not due to the dominance of more forceful or vociferous debaters, but rather is due to each reviewer's coming to a better understanding of the intrinsic nature of the material presented. Thus, rather than interreviewer agreement as the measure of reliability used for the journal manuscript analyses [Chicchetti, 1991], for research program peer review a better measure of reliability may be agreement of average panel scores after panels are conducted in the interactive mode suggested above.

EFFECTIVENESS/ PREDICTABILITY OF PEER REVIEW

The issue of peer review predictability affects the credibility of technological forecasting directly. For an organization conducting peer review of research, it would be desirable to relate the reviewers' scores to downstream impacts on the organization's mission [Abrams, 1991; Van den Beemt, 1991, 1997]. A few studies have been done relating reviewers' scores on component evaluation criteria to proposal or project review outcomes (e.g., [DOE, 1982; Kostoff, 1992a]). Some studies have been done in which reviewers' ratings of research papers have been compared to the numbers of citations received by these papers over time [Bornstein, 1991a; Bornstein, 1991b]. Correlations between reviewers' estimates of manuscript quality and impact and the number of citations received by the paper over time were relatively low. Bornstein concludes, after an extensive survey of peer review reliability and validity, that: **"If one attempted to publish research involving an assessment tool whose reliability and validity data were as weak as that of the peer review process,**

there is no question that studies involving this psychometrically flawed instrument would be deemed unacceptable for publication." [Bornstein, 1991b].

The author is not aware of large-scale studies, singly or in tandem, that have related peer review scores/rankings of proposals to downstream impacts of the research on technology, systems, and operations, although some efforts toward this end have been initiated [Van den Beemt, 1991]. This type of study would require an elaborate data tracking system over lengthy time periods which does not exist today. Thus, the value of peer review as a predictive tool for assessing the impact of research on an organization's mission (other than research for its own sake) rests on faith more than on hard documented evidence.

COSTS OF PERFORMING A PEER REVIEW

Another problem with peer review is cost [ASTEC, 1991; Buechner, 1974; Hensley, 1980; Kostoff, 1995d, 1996a]. The true **total** costs of peer review, as will be shown, can be considerable but tend to be ignored or understated in most reported cases. Because there are many different types of peer review, it is very difficult to provide a total cost rule-of-thumb for generic peer review. Nevertheless, consider the following illustrative example for an order of magnitude estimate on total research program peer review costs [Kostoff, 1995a].

Assume that an interim peer review is desired of a $1M/yr program at a laboratory. The review mode of operation will be to bring a panel of experts to the laboratory site for two days, and hear presentations from the principal investigators. Assume that the panel consists of ten experts in research, technology, mission operations, etc., and that eight principal investigators will present their projects to the panel. The loaded cost (salary plus overhead) for each panel member is assumed to be $150,000 per year, and the loaded cost for each principal investigator is assumed to be $125,000 per year. Direct expenditures, such as panel per diem and travel costs, would be in the neighborhood of $6,000-8,000. Any honoraria would increase this cost.

Indirect expenditures, such as total reviewer, presenter, staff, and review audience time spent toward the review, would be in the range of $125,000 and would include at least the following:

1. Presenter time in preparing background material for reviewers to read before review, preparing the presentation, making dry runs for management, etc. [$40,000 estimate; 80 person-days];
2. Panel member time for reading background material (papers, reports, plans), traveling to review, spending time at meeting, writing report, etc. [$48,000-60,000 estimate; 80-100 person-days];
3. Agency staff time for identifying and soliciting reviewers, establishing review and coordinating with lab, writing reports, etc. [$10,000 estimate; 20 person-days];
4. Audience (lab management, other lab personnel, other agency representatives, etc.) time at review [$20,000 estimate; 40 person-

days].

The main conclusion of this discussion is that for serious panel-type peer reviews, where sufficient expertise is represented on the panels, total real costs will dominate direct costs. This conclusion would also be true for mail-type peer reviews. While the total costs of mail-type peer reviews would be less than those of panel-type peer reviews due to the absence of travel costs, the ratio of total costs to direct costs for mail-type peer reviews would be very high. The major contributor to total costs for either type of review is the time of all the players involved in executing the review. With high quality performers and reviewers, time costs are high, and the total review costs can be a non-negligible fraction of total program costs, especially for programs that are people intensive rather than hardware intensive.

ETHICAL ISSUES IN PEER REVIEW

In the research profession, there is a plethora of ethical issues, including scientific fraud, scientific misconduct, betraying confidential information, and unduly profiting from access to privileged information. There are both legal and unwritten/ unspoken agreements and penalties which underly the maintenance of ethical standards in these areas. One subordinate objective of peer review, whether at the manuscript [Fox, 1994], proposal, or program level, is to maintain high ethical standards, especially as applied to fraud and misconduct. Since many of the fraud and misconduct violations have occurred in the written technical product, most of the reported applications of peer review in this area have emanated from journal peer review [Fielder, 1995; Goodstein, 1995; Gupta, 1996; Keown, 1996; Mokrasch, 1988; Moran, 1992; Southgate, 1992]. The maintenance of ethical standards in these areas tends to be through self-policing by the research community. The author has seen no program peer reviews in which fraud and misconduct were uncovered, and has not identified any such cases in the literature.

There is a fundamental ethical paradox which underlies any form of research peer review. For the review process to have credibility, experts must be employed, either for the <u>right job</u> function or the <u>job right</u> function. Contrary to popular opinion, it has been the author's experience, based on directed experiments and on personal observations during the conduct of reviews, that there are very few real experts in any specific research field. Armstrong [Armstrong, 1997] draws a similar conclusion relative to manuscript peer review, to the effect that the reviewers may work on similar areas but not the same specific problem, so that the reviewers have less experience on the total problem than do the authors. Thus, in order to obtain real experts for a panel, at least to evaluate the <u>job right</u> aspects of the research, a relatively small community must be accessed. Usually, the members of this community are acquainted with each other, and are either research collaborators or research competitors. They may compete

for funds or awards or prestige or promotions, or other types of recognition. Thus, there is an inherent bias/ conflict of interest in the process when real experts are desired as reviewers.

Usually, in research program peer review, there are (or should be) documents which reviewers sign to protect the confidentiality of the research being reviewed, but pragmatically it is the adherence to the unwritten and unspoken ethical standards which restricts the unwarranted use of proprietary and sensitive information. There are also legal protections, and recently there have been court cases brought by those who felt their confidences and proprietary research had been violated through illegal expropriation of the results for personal reviewer gain.

No matter what documents reviewers sign, nor what desires they have to adhere to the highest ethical standards, they cannot help but be influenced by the privileged information to which they have access. The transfer of knowledge occurs through many pathways, and listening to detailed technical presentations or reading technical proposals are probably two of the more effective. Thus, the operative solution to the ethical dilemma posed by access to technical material is the principle of compromise rather than the compromise of principles. The ethical reviewer takes no conscious overt actions to reveal confidences or profit unduly from participation in the peer review, but rather accepts as his reward for participation the satisfaction of having aided the larger research enterprise and having improved his thought processes from exposure to different ideas. If the larger use of research program peer review becomes a reality, and if the outcomes are used to influence budgetary decisions, then more efforts need to be devoted to insure adherence to some of the ethical standards discussed here.

ALTERNATIVES TO PEER REVIEW

This paper has identified a number of problems associated with the use of peer review. These problems conceptually transcend the different peer review applications of program, proposal, and manuscript evaluation, although the implementation severity of different problems is different for each of the applications. There have been a number of proposals for peer review modifications or complete alternatives [Forsdyke, 1991; Greene, 1991; Roy, 1981, 1984, 1985; Smith, 1988; Wick, 1996; Wood, 1997], in attempts to overcome the most egregious aspects of peer review. Most of these alternative concepts focus specifically on research proposal peer review, although some of their component ideas apply to the other applications of peer review as well. Two of the more widely known alternatives will now be presented and critiqued.

Bicameral Review

A modified form of peer review for project selection has been propounded in recent years by some Canadian scientists [Berezin, 1995; Forsdyke, 1991]. This methodology has been termed "Bicameral Review" by its originator, Dr. Forsdyke, and its essence is as

follows.

The structure of Bicameral Review is founded on the assumption that the research funding system is highly error-prone due to the inherent uncertainty of predicting the outcome of basic research. If an evaluation system is highly error-prone, then that error-proneness has to be taken into account in system design. Two principles of decision-making in uncertain environments are: 1) place most weight on parameters most likely to be assessed with some degree of objectivity, and 2) hedge your bets.

In Bicameral Review, grant applications are divided into a major retrospective part (track record of proposers), and a minor prospective part (the work proposed), which are routed separately. The retrospective part only is subjected to peer review. The prospective part is subjected to in-house review by the agency, solely with respect to budget justification. The peers are required to assess not just productivity, but productivity per dollar received. Furthermore, they have to factor in the experience of the applicant. Young researchers are given more funding "rope" (the benefit of the doubt), until they have established a record. Funding is allocated on a sliding scale, replacing existing sharp fund-no fund cutoffs. Only those at the very top of the funding scale would get all the funds they needed to complete the work in a reasonable time. As the merit rating of the projects decreased down the funding scale, the fraction of requested funds would decrease as well.

Productivity-Based Formula Systems

A non-peer review alternative has been proposed [Roy, 1981, 1985], based on the principles that past success is the best predictor of future performance, supporting small groups on a continuing basis for a reasonable time period increases probabilities of success and system efficiencies, and most innovative science is done with a minimum of micro-management. This alternative proposes that researchers be funded essentially based on track record, and provides an algorithm for allocating funds. In one algorithmic incarnation [Roy, 1985], the dollars awarded would be proportional to some weighted sum of numbers of publications, numbers of advanced degrees, dollar volume of research support from mission agencies, and dollar volume of research support from industry, and the award would be to a research unit (Departments, etc). Again, the underlying principle is that performance rather than promise will provide a much firmer basis for public accountability. New investigators added to a research unit would have extra shares added to the base formula allocation.

Author's Commentary on Alternatives

Ideally, a research proposal evaluation process should be able to allocate funds to the ideas with the greatest potential, independent of the source of these ideas. Such a process should be able to include ideas from established researchers with strong track records, established researchers with weak track records, and

new researchers with no track records. It should be able to cover researchers from academia, government, and industry, ranging from one person operations to very large organizations, and cover classified and non-classified work with different venues and cultures for reporting research results. The allocation process should incorporate the best technical judgements in arriving at final decisions, recognizing the uncertainties involved in projecting the outcomes of fundamental research.

The two alternative approaches selected place heavy emphasis on awards to established researchers with strong track records, although they differ in how the track records would be determined, with Bicameral using peers and productivity-based using a formula. Both minimize the use of true technical experts in the evaluation of the prospective portion of proposed research. In actual practice, these alternatives would not differ quite as significantly from existing peer review processes as might be imagined from first reading. As stated previously in this paper, analyses have shown that Team Quality, a euphemism for performer track record, is the dominant factor in determining reviewer overall quality score for existing and proposed research. Thus, both the existing and alternative approaches de facto place heavy emphasis on track record. The real difference between the alternatives and the existing approaches, in the author's opinion, is the use of technical experts in evaluating the prospective portion of the proposal.

While both alternative approaches would reduce the cost of submitting proposals to some degree, would reduce the impacts of reviewer bias, would reduce substantially whatever pirating exists of novel ideas by competitors, and would eliminate some unnecessary time expenditures in the review processes, they have some drawbacks. Extremely heavy emphasis on track record to the exclusion of expert judgement on proposed concepts promulgates continuation of orthodox mainstream approaches by increasing the obstacles to new entrants into the research arena. Lack of technical expertise in the judgement of proposed research could lead to more non-technical factors predominating in the selection process, and the relative ascendance of form over substance in the evaluation.

In a zero-sum game, the Bicameral Review process appears to allocate some funds from the 'best' proposals to the 'worst' proposals because of the sliding scale and elimination of the sharp cutoff. It does, however, provide a 'safety-net' which allocates some funding to all, or almost all, researchers.

The productivity based system has some analogies to the present GPRA approach addressed in the companion Science article [Kostoff, 1997h], and suffers from many of the same drawbacks. Use of any metric or combination of metrics as a stand-alone approach for evaluating research is subject to error. The metrics chosen may or may not be a valid indicator of research quality; interpretation by peers is required to validate the credibility of the metrics. The formula based approach has the negative potential of driving researchers to achieve numerical output targets rather

than fundamental understanding.

The productivity approach is similar to a recursive system of equations, and if the initial conditions are flawed, the final figure of merit would be flawed. For example, one of the formula terms is dollars received for research from mission agencies. Suppose a research team had received major grants that were 'earmarked' in legislation. This could lead to better numbers for at least two of the other formula terms as well, numbers of graduate students and papers produced, and then result in a high overall figure of merit that was not necessarily related to the intrinsic quality of the research program. This allocation based on flawed initial conditions would recur each year until it became a self-perpetuating system, even after the 'earmarking' was terminated. Thus, if any formula or combination of quantitative indicators is used, it must be accompanied by and subordinate to expert peer review, in order to avoid the occurrence of situations such as the one above.

These alternatives, and others of similar nature, are based on the premise that the peer review selection process does not yield the best research, and the tremendous expenditures of time and energy in generating proposals do not justify the continuance of such an inexact process. The validity of this basic premise can be challenged. While peer review has its imperfections and limitations, there is little evidence that the best researchers and ideas are going without funding, and far less evidence that the alternatives above would improve the situation.

SCIENCE COURT

A non-standard peer review approach for concept evaluations is the Science Court. As in a legal procedure, it has well defined advocates, critics, a jury, etc. It is a unique and potentially powerful technique, but like any tool, can be misused if not understood and applied properly. It was applied in the magnetic fusion office by the author to a review of alternate fusion concepts in 1977 [DOE, 1978].

The general format selected for the evaluation was a panel review by selected evaluators with an adversary type of procedure. The participants and their roles in the evaluation are described below.

The steering committee consisted of fusion office representatives. The chief responsibilities of this committee were (1) to organize the evaluation, (2) to define the evaluation criteria, (3) to choose members of the Evaluation panel, (4) to assist the Evaluation panel in the reviews, and (5) to receive the evaluators' conclusions and recommendations and draft a final report to the fusion office.

The Evaluation panel was composed of plasma physicists, fusion reactor systems experts, and a representative of the utility industry. The panel did not include active proponents of any of the concepts under consideration. In case of a remote conflict of interest, a panel member excused himself from the deliberation on

the particular concept involved. The panel was responsible for the technical evaluation of all concepts.

The Advocates of a concept were those scientists and engineers who were working on a particular concept. The Advocates were responsible for providing and defending scientific results and projections, as well as the technology and attractiveness of the reactor embodiment. A Chief Advocate was designated to coordinate the activities of the Advocates.

Critics were chosen for their special expertise in an area of physics or engineering that was important to a particular concept. The Critics' responsibility was to ferret out crucial physics and technology questions and to aid the Evaluation Panel in the review of experimental results and theoretical models. Proponents of one concept in some cases served as critics in the evaluation of another concept. One person was chosen as a Chief Critic and was given the responsibility of coordinating the activities of the Critics.

Any of the participants (Advocates, Critics, or the Evaluation Panel) were allowed to utilize outside experts as they deemed appropriate. This procedure probably had more debate and surfacing of crucial issues than any other concept evaluation seen by the author. However, it was time-consuming compared to a standard panel assessment.

IV-A-3. PEER REVIEW PRACTICES

PROPOSED PROGRAMS

1) NSF

The two largest Federal sponsors of basic research are the National Institutes of Health (NIH) and the National Science Foundation (NSF) [NSF, 1996]. The NSF peer review process of research proposals illustrates how potential research impact influences selection of new research areas. In the NSF process, proposals received are assigned to program officers for review. The program officers select external peer reviewers and use mail and/or panel approaches to have the proposals assessed and rated. The program officers then perform their own assessment of the proposals and forward their recommendations to higher levels. These recommendations are rarely overturned [Frazier, 1987].

From the the 1987 version of the NSF Brochure, Information for Reviewers, reviewers use four criteria to assess the proposals:

1. Research Performance Competence;
2. Intrinsic Merit of the Research;
3. Utility or Relevance of the Research;
4. Effect of the Research on the Infrastructure of Science and Engineering.

These criteria were adopted by the National Science Board in 1981 [NSF, 1997].

Research impacts are evaluated through the second, third, and fourth criteria. The second criterion, Intrinsic Merit, incorporates impact of the proposed research on other research fields in its definition and is a measure of the nearer term impact of the proposed research. The third criterion, Utility, addresses potential contribution to an extrinsic goal such as a new technology. The fourth criterion, Infrastructure, incorporates impact on the nation's research/ education/ human resource base.

In 1996, the NSF merit review process was evaluated by a task force. The National Science Board recommended that the new review criteria proposed in the final task force report [NSF, 1977] be approved for implementation on October 1, 1997. The specific task force recommendations are that the following two criteria be adopted in place of the four criteria that are currently used.

1. What is the intellectual merit of the proposed activity? The following are suggested questions to consider in assessing how well the proposal meets this criterion: How important is the proposed activity to advancing knowledge and understanding within its own field and across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, please comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

2. What are the broader impacts of the proposed activity? The following are suggested questions to consider in assessing how well the proposal meets this criterion: How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, network, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

The task force further recommended that a cover sheet be attached to the proposal review form, which presents the context for using the criteria. The suggested language for this cover sheet is as follows:

Important! Please Read Before Beginning Your Review!

In evaluating this proposal, you are requested to provide detailed comments for each of the two NSF Merit Review Criteria described below. Following each criterion is a set of suggested questions to consider in assessing how well the proposal meets the criterion. Please respond with substantive comments addressing the proposal's strengths and weaknesses. In addition to the suggested

questions, you may consider other relevant questions that address the NSF criteria (but you should make this explicit in your review). Further, you are asked to address only questions which you consider relevant to the proposal and that you feel qualified to make judgements on.

When assigning your summary rating, remember that the two criteria need to be weighted equally. Emphasis should depend upon either (1) additional guidance you have received from NSF or (2) your own judgement of the relative importance of the criteria to proposed work. Finally, you are requested to write a summary statement that explains the rating that you assigned to the proposal. This statement should address the relative importance of the criteria and the extent to which the proposal actually meets both criteria.

Regarding the 'ratings' issue, which was highlighted in the Discussion Report, the task force recommended that the NSF 'generic' proposal review form provide for the following:

1. separate comments for each critierion
2. single composite rating
3. a summary recommendation (narrative) that address both criteria

In the new process, research impacts are the focus of the second criterion. These include impacts on infrastructure, education, science, technology, and diversity. Thus, not only are technical impacts considered, but potential socio-political impacts are considered as well. Finally, it is unclear how other unwritten criteria, such as government vs industry appropriateness for funding, which may be important for a specific project/program, would impact the composite rating.

2) NIH

In the NIH process, proposals are sent to initial peer review groups, composed mainly of active researchers at colleges and universities, where they are reviewed for scientific and technical merit. After receiving a priority rating from the peer reviewers, the proposals are then sent to a statutorily mandated advisory council, composed of scientists and public members, for a program relevance review. After the council members recommend action to be taken on the proposals (usually concurrence with the peer group recommendations, but sometimes special action [Frazier, 1987]), the institute staff rank the proposals and initiate a funding strategy.

In response to a perceived need to refocus the review of grant applications on the quality of the science and the impact it might have on the field, rather than on details of technique and methodology, NIH has developed five new criteria for initial review of proposals for implementation in October 1997. Reviewers will be asked to apply the criteria in judging whether the proposed

research is likely to have a substantial impact on advancing the goals of NIH-supported research: advancing understanding of biological systems, improving control of disease, and enhancing health. The new rating criteria are:

Significance: Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge be advanced? What will be the effect of these studies on the concepts or methods that drive this field?

Approach: Are the conceptual framework, design, methods, and analyses adequately developed, well-integrated, and appropriate to the aims of the project? Does the applicant acknowledge potential problem areas and consider alternative tactics?

Innovation: Does the project employ novel concepts, approaches or method? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?

Investigator: Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and other researchers (if any)?

Environment: Does the scientific environment in which the work will be done contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

In assigning a single global score for each application, the reviewers are to consider all criteria, weighting each criterion as appropriate for each application.

It appears that only the first criterion, Significance, relates to impact, and can include the relatively near term impact on allied research fields. Broader impact and relevance issues appear to be the purview of the advisory councils. The council members are asked to assess the fairness and appropriateness of the initial scientific review as well as the proposal's relevance to institute research program goals and broader societal health-related matters.

3) ONR

The ONR does not require formal peer review of individual research grants, but leaves the choice of peer review to its scientific officers. Circa 1992, it required a competitive process among internal Navy organizations (claimants) with external reviewers for those accelerated program proposals which constituted about 30 per cent of the total ONR program [Kostoff, 1988, 1991a, 1992a]. The claimants that won the competition then went to the

technical community (if their charter was extramural) and advertised their areas of interest for proposals, or, if their charter was intramural, performed the work in-house.

In a detailed description of the competition [Kostoff, 1988], all the accelerated programs proposed by the claimants (ARIs) were categorized into areas of similar science, and the proposals in each area were evaluated by a panel of experts external to ONR. The written portion of the evaluation required numbers and comments for factors related to research quality and Navy relevance. In this process, the factors on the scoresheet relating to potential research impact estimation were:

1. Research Merit (RM);
2. Potential Impact on Naval Needs (PINN);
3. Potential for Transition or Utility (PTU).

The Research Merit criterion incorporates the potential impact of the research, if successful, on allied research areas. The Potential Impact on Naval Needs criterion deals with downstream impact of the proposed research on naval systems and operations. The Potential for Transition or Utility criterion incorporates the potential nearer term impacts of the proposed research. Transition refers to the actual transfer of research programs to development and Utility refers to other mechanisms by which a program's results would be transmitted to, and used by, the technical community.

A key component of this process was the use of mixed levels of reviewers on the panels to evaluate the different potential impacts of research. The panels included bench-level researchers to address the impact of the proposed research on the field itself; broad research managers to address potential impact on allied research fields; technologists to address potential impact on technology and the potential of the research to transition to higher levels of development; systems specialists to address potential impact on systems and hardware; and operational naval officers to address the potential impact on naval operations. The presence of reviewers with different research target perspectives and levels of understanding on one panel provided a depth and breadth of comprehension of the different facets of the research impact that could not be achieved by segregating the science and utility components into separate panels and discussions. The interplay among reviewers coming from different perspectives allowed each reviewer to incorporate elements of other perspectives into his decisionmaking process.

A multiple regression analysis showed RM to be the most important factor in determining the bottom line score [Kostoff, 1992a]. PINN did not weigh as heavily in the reviewers' bottom line score as did PTU. The reviewers weighed nearer-term impact more heavily in their bottom line decisions, as evidenced by the higher correlations of PTU. Since the study also showed that the bulk of the proposed ARIs was viewed by the reviewers as basic research, and since the (possibly far) downstream naval impact of basic research may not be evident in many cases, it is not

surprising that the more identifiable near-term impacts, such as transition to exploratory development or utility of results by other researchers, would affect reviewers' bottom line decisions more than the long term impacts.

4) STW-NETHERLANDS

The Dutch Technology Foundation (STW) was founded in 1981. One of its main functions is to fund university research that is of high scientific quality and has the potential to lead to results that can be used by external bodies. In 1981, STW opted for a new system for the assessment and appraisal of research proposals from individual researchers (Van den Beemt, 1991, 1997). STW devised this new system in order to minimize the problems of selection by large committees, by colleagues, by a few peers only or by organizations belonging to the discipline concerned.

The system operates as follows: All applications belonging to the broad field of technology and engineering sciences are welcome. Every application is sent initially to six peers who are specialists in the topic covered by the proposal; some are university staff, others work in industry. STW asks peers, first by telephone and later by mail, to give comments based on two criteria: scientific quality and utilization potential.

These criteria incorporate the following sub-criteria: Subcriteria relating to scientific quality: competence of a team, originality of the proposal, effectiveness of the proposed method, the program itself, time schedule, available infrastructure and estimated costs.

Subcriteria relating to utilization potential: applicability of the results, commercial outcomes, long-term contribution to technology, influence on the competitive status of Dutch industry and the importance of patents in the field.

From the comments received, the program officer at STW compiles a document in which the comments are sorted according to sub-criteria. This document is then sent to the principal investigator who is allowed to reply to each comment; the investigator's actual words are then typed in italics directly under each comment. The complete document, called a protocol, provides information for and against the proposal. When the protocols for 20 proposals (regardless of the topics concerned) are ready, a jury is formed consisting of 12 highly qualified persons coming from universities, government laboratories and industry. Their disciplines and backgrounds vary widely. No jury member knows who else is on the jury; names are not divulged. The work is done free of charge and each member of the jury is only allowed to participate once: the next 20 proposals are handled by a new jury.

The STW board gives a grant to at least the best 8 proposals. This minimum grant percentage of 40 per cent is never influenced by resource allocations. If STW resources were to become insufficient to operate this system, STW would stop accepting proposals for a while.

According to its proponents, this procedure has proved to be reproducible, and in the Netherlands it is widely accepted.

Because the system is reproducible and objective, STW gets hardly any resubmissions. A proposal resubmitted to STW will be almost certain to receive the same assessment as the original proposal. A notable feature of the procedure is that it is very dynamic: for instance, there are no fixed groups of influential people within STW. Every year about 50 per cent of the peers are new. Jury members serve only once. The STW board does not set additional priorities once the priority rating has been established by the external assessors.

Opinions on the quality of the proposed research can differ considerably. STW has performed many studies to ascertain whether the STW process really works. They have checked the reproducability of the jury judgement. The have also checked that their procedure does not discriminate with regard to age or budget. Their evaluation of the research results 10 years after the proposal was granted shows that there is a correlation between the outcomes and the jury's assessment of the utilization potential. Furthermore, their jury system ensures that original proposals receive grants, which would not be the case if STW had relied solely on bibliometric indicators (see van den Beemt & van Raan 1995).

After a proposal has been granted, STW immediately forms a users' committee for that particular research project. The committee meets twice a year at the university where the research is taking place. The research team gives an overview of their work, and discusses this with the 'users'. The 'users' are mainly experts, but sometimes they are managers and/or, if appropriate, government representatives. STW regards this as an effective partnership. Most funding-agencies (after granting a project) neglect this aspect of the process and ask only for annual reports on the granted research project or they visit the groups once every two years. STW, on the other hand, constantly involves the potential users from society as the research progresses. They evaluate the projects one year and six years after the project has ended.

STW concludes that Peer Review can be relevant when it involves more than 5 peers and they are asked only for their comments. The comments of peers need to be assessed by a number of highly qualified people (non-peers). STW believes that the people involved in the peer and jury procedures must not meet and must work by mail. STW believes that it is not a good idea to work with fixed groups of peers and jury members. STW also believes that bibliometric indicators have nothing to do with scientific quality; they simply indicate numbers of publications and citations. They should not be used for the assessment of research proposals.

PEER REVIEW PRACTICES: EXISTING PROGRAMS

There are many approaches used by research sponsoring organizations to conduct periodic peer reviews to monitor the quality and potential impact of ongoing research [Salasin, 1980; Logsdon, 1985; DOE, 1993; Kostoff, 1995a; Ormala, 1989; Cozzens,

1987; Kerpelman, 1985; Luukkonen-Grunow, 1987; OTA, 1986]. This section focuses on selected peer review approaches which reflect the state of the art in the technical community and pays special emphasis to how research impact is incorporated into the peer review process. The first case study is the DOE review of its Office of Basic Energy Sciences (BES), and the evolution of that approach into present DOE practice. The second case study focuses on the ONR methods used to review extramural and intramural programs. The third and fourth case studies relate to the annual reviews of the National Institute of Standards and Technology (NIST) and the Army Research Laboratory (ARL) by the National Academy of Sciences (NAS), and the fifth case study relates to the annual review of the DOE national laboratories by the field offices. The final case study describes an approach used by the author to evaluate a program of small high-risk seed money projects.

In 1981, the DOE performed an assessment of existing projects funded by its office of Basic Energy Sciences [DOE, 1982; Kostoff, 1988]. Out of approximately 1200 active projects supported by BES, a randomly selected sample of 129 projects was reviewed by panels of scientific peers. The projects were grouped by areas of similar science, and the reviews were conducted on 40 separate days by 40 separate expert panels, with an average of four members and three projects per panel. The reviewers were, for the most part, bench level scientists independent of the DOE.

The reviewers were asked to rate seven factors for each project:

1. Team Quality (TQ);
2. Scientific Merit (SM);
3. Scientific Approach (SA);
4. Productivity (P);
5. Importance to Mission (IM);
6. Energy Impact (EI);
7. Overall Project Quality (OPQ).

The three evaluation factors on the scoresheet which related to potential research impact were SM, IM, and EI. SM incorporated the potential impact of the research on allied research fields. IM covered the types of ways in which a research project could contribute to the Nation's energy needs. EI was the probable impact of the research project on energy development, conservation, or use.

After the scoring by the panels was completed, all possible linear regression models (ranging from six-factors to one-factor) were used to relate the OPQ rating factor (essentially the reviewers' bottom line score on each project) to the other rating factors for the 129 projects. The six-factor model produced a correlation coefficient of 0.89, which meant that the six-factors selected constituted the bulk of the considerations which the reviewers used to score the OPQ rating factor. In fact, the best three-factor model derived to predict the OPQ rating factor score,

consisting of TQ, SA, and IM, produced correlation coefficients within three percent of the complete six-factor model [DOE, 1982].

An updated version of the BES evaluation approach is used by the DOE Office of Program Analysis to conduct peer review assessments of DOE research and development [DOE, 1993]. Now, after a panel has completed the evaluation of all the projects assigned to it, the members are asked to identify research needs or opportunities available to the DOE research program. Since the panel members are very familiar with the program strengths and weaknesses at this point in the review, the opportunities and needs that they identify should be viewed as highly relevant and credible.

Each of ONR's review processes has a major peer evaluation component adapted to meet the particular needs of the organizational unit under review. The two reviews described here are those of ONR's two largest research claimants circa 1992, the Research Programs Department (RPD) and the Naval Research Laboratory (NRL).

The RPD sponsored extramural basic research mainly at universities, and consisted of 13 Divisions organized along science disciplines. Two separate groups contributed to the one day annual review of each Division. One group was the Division's Board of Visitors (BOV), which represented academia, industry, and non-ONR government. The majority of the BOV were members of the research community, but typically the BOV would include representatives from the technology development community and the operational Navy. The other group contributing to the review was the Research Advisory Board, the senior management of the RPD whose backgrounds spanned a wide range of scientific disciplines.

For the review, the Division Director overviewed the total Division, including programs, accomplishments, new opportunities, and management issues. The Division's program managers described their programs in detail, including the impact on science of their accomplishments, potential or ongoing transitions of their programs to development programs, some bibliometric measures such as publications, and potential impacts on the Navy if successful. The reviewers filled out comment sheets, focusing on Scientific Merit, Technical Approach, and Potential Naval Impact, and later discussed their findings with the RPD management.

Almost all of the NRL's programs are intramural, and it conducts full spectrum research in 60 task areas. On average, about 20 task areas will be reviewed per year, with 4 or 5 of these task areas reviewed using external reviewers, and the remainder reviewed by an internal NRL management group called the Research Advisory Committee (RAC). The external review group represents academia, industry, and non-NRL government. The RAC consists of NRL senior management whose backgrounds span a broad range of science disciplines.

The Coordinator of the task area reviewed by the external panel overviews the task area and investment strategy. Then, the principal investigators of the task area describe their work in detail, including the impact of their science accomplishments on

the task area and allied science fields, transitions to more applied categories, bibliometric measures such as publications and presentations, and potential impact of their research on the Navy.

The reviewers fill out comment sheets, focusing on Scientific Merit, Technical Approach, and Potential Naval Impact, and afterward visit and review facilities. The reviewers draft a report and meet with ONR management and members of the RAC to present their preliminary findings. The remaining task areas are reviewed in detail by the RAC.

NIST is reviewed annually by two external groups, a general policy and management review, and a detailed technical review. The Visiting Committee on Advanced Technology reviews general policy, organization, budget, and programs of NIST. The Committee submits an annual report [NIST, 1991a] which includes reviews of progress in NIST's science, engineering and technology transfer programs.

The National Academy of Sciences' (NAS) Board on Assessment of NIST Programs performs a detailed technical review [NIST, 1991b]. Seventeen panels of reviewers (about ten people per panel) from industry and academia conduct program reviews based on 2 or 3-day site visits at NIST facilities. The panels address variants of research quality, and because of NIST's unique charter in supporting competitiveness, pay particular attention to technology transfer, industrial coupling, and emerging technologies. While quantitative indicators of research impact are not addressed in the panels' annual reports [NIST, 1991b], impacts of the research on technology and competitiveness are addressed extensively. Recommendations for improvement in these impact areas are provided.

Recently, the ARL contracted with the NAS to establish a Technical Assessment Board (TAB) and associated review panels for the purposes of evaluating the quality of the ongoing research, assessing of the state of the laboratory's facilities, and appraising the level of preparedness and functioning of the technical staff. The TAB has 15 members with expertise in fields aligned with ARL's six business areas (Vehicle Technologies, Weapons and Materials Research, Information Science and Technology, Sensors and Electronic Devices, Human Research and Engineering, Survivability and Lethality Analysis), and its members come mainly from Academia and Industry. The NAS established six review panels (one for each business area), each one consisting of about ten members including some TAB members. Each panel reviews one third of the program in its business unit area per year; each full business unit is therefore reviewed on a three year cycle. Each review consisted of a two day site visit by the panel. The review included briefings on technical projects, touring the lab to assess the facilities and equipment, interacting personally with the research staff, and reviewing those portions of the ARL extended program being conducted with private sector partners under a Cooperative Agreement (Federated Laboratory; in essence, the addition of virtual lab divisions). An annual report contains the review results [Brown, 1997].

The DOE has nine contractor-operated multiprogram laboratories. Each contractor's laboratory management performance

is evaluated annually by the DOE Field Office (FO) to which each laboratory is assigned [DOE, 1988]. The FO prepares an appraisal plan for the laboratory, which focuses on laboratory performance in four areas:

1. Institutional Management Performance, which includes different aspects of overall lab management;
2. Programmatic Performance, which includes R&D achievements;
3. Operations Support Performance, which includes technical functions which support mission objectives;
4. Administrative Performance, which includes business management functions.

In the programmatic performance areas, sources of input include DOE program officials, other agencies having substantial work at the laboratory, and FO program managers. For this annual review, DOE will utilize information from its own program advisory committees on the adequacy and impact of the laboratory's R&D efforts in relation to the overall DOE program. Furthermore, DOE will use the reports of the scientific peer review committees established by the contractor, which provide an assessment of the quality of the laboratory's R&D programs.

There appears to be no formal requirement for using teams of external reviewers for the technical programs as in the ONR and NIST reviews; rather, most input seems to come from the sponsors. Estimations of research impact appear to derive from the DOE program advisory committees and peer review assessments, which may be reflected in the annual appraisal.

In Europe, panel reviews have evolved where users of the research results together with scientific peers assess the impact of the research on scientific progress and industrial or social development. Another development line has been to commission evaluation experts either to support panels or to conduct independent assessments which may involve surveys, in-depth interviews, case studies, etc [Ormala, 1994]. A 1992 publication [Barker, 1992] describes how evaluation experts coming from two main communities (civil servants and academic policy researchers) interact in evaluation of R&D in the UK. The performance of evaluations, including the synthesis of evidence and the production of conclusions and recommendations, is done by professionals, as opposed to panels of eminent persons. No comparisons of reviews by the professionals with those of eminent persons are presented.

IV-A-4. PEER REVIEW PROTOCOLS

The previous parts of this section have focused on concepts, principles, and issues related to research program peer review, as well as examples of selected federal agency peer review practices. The remainder of this section incorporates many of these ideas into a sample program peer review process. Sufficient detail is presented such that an organization could use this as a guide to developing a review process most appropriate to its needs. Most of

the procedures and concepts described have been tested and found to produce very useful results.

Program Review Options

The guiding principle for review options is that evaluation should occur along the same structures and taxonomies by which the research is planned and executed. If the agency has a separate research unit, then the discipline should be evaluated as an integrated whole. In the nominal intra-agency review, quality and relevance could be evaluated concurrently or separately, as desired by the agency.

If research is vertically integrated with development, then the research could be evaluated as part of a total vertical structure R&D review [Kostoff, 1995a] or as part of the discipline, as desired by the agency. In the nominal intra-agency review, quality and relevance could be evaluated separately or concurrently. A key conclusion to be drawn from this paragraph is that research evaluation recommendations must take into account how research is structured, integrated, and managed within an agency.

Desirable characteristics of a high quality peer review were listed previously under the Objectives section. The research programs should be reviewed on a trienniel cycle, based on the DOE BES evaluation results of 1982 [DOE, 1982], and on other agency practices.

The following considerations apply to a concurrent quality and relevance review. The reviewers should be external, have minimal conflicts with the program being reviewed, and should be selected with expertise in all facets of the research and potential impact areas. To evaluate the degree of horizontal coupling in the nominal intra-agency review, representatives of other Federal agencies should be considered as reviewers, or at least should be invited to participate as audience members. Thus, the review panel will be a heterogeneous mixture of research and relevance experts who can address the many facets of the science and areas of potential impact.

In the nominal concurrent quality and relevance review, quality and relevance should be the main review criteria. Research quality criteria should include research merit, research approach, productivity, and team quality. Relevance criteria should include short term impact (transitions and/or utility), long term potential impact, and some estimate of the probability of success of attaining each type of impact.

There should be an overview showing how the larger management unit (Division, Department, etc.) in which the programs are housed integrates into the total organization, and how the management unit's objectives relate to those of the larger organization. Then, the investment strategy of the larger management unit should be presented in detail. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. Finally, for each program presentation, the investment strategy for its thrust areas should be presented.

The investment strategy is perhaps the most crucial part of a program review, and deserves further discussion here. While investment is the allocation of resources among the program components, the investment strategy is the rationale for the prioritization and allocation of resources among the program components. The optimal investment strategy for a program, which should be a focal point of an assessment, is that allocation and rationale which will produce the most mission relevant high quality research for impacting the program's objectives. This will depend on the viewpoint of the assessor, and in particular how the assessor limits the role of the research within the national perspective.

The optimal investment strategy results from a timely confluence of research requirements (top-down driven) and promising research opportunities (bottom-up driven). Further, promising research opportunities result from a timely confluence of advances in theory, instrumentation, new experiments, new algorithms, and computers. Finally, research requirements result from a timely confluence of domestic and foreign, political and economic, strategic and tactical advances. All of the above factors should be included in a presentation of the investment strategy.

While the emphasis is on peer review, bibliometric and other type of indicators should be utilized. Also, it is recommended strongly that sufficient background material be supplied to the reviewers before the review. This would include organizational descriptive material, narrative descriptions of each program to be reviewed, and descriptive material of each work unit in the program. It would also prove useful to include bibliometric output indicators for each program, with interpretive analytical material. This could include refereed papers, patents, awards and honors, presentations, etc. It would be useful to include narrative material on related programs in other agencies and industry. It would be useful to include Hindsight-type results of research that was funded years ago in the discipline under review and which recently came to fruition in a system or commercial technology. Finally, although the following concept has never been tested to the author's knowledge, it would be valuable to incorporate the results of journal manuscript reviews in the research program peer review process.

The best features of different organizations' peer review practices can be combined with some of the principles above into a protocol for the conduct of successful peer review research program evaluations and impact assessments. The main aims of the protocol are to insure that the final assessment product has the highest intrinsic quality and that the assessment process and product are perceived as having the highest possible credibility. The protocol elements are:

1. The objectives of the assessment must be stated clearly and unambiguously at the initiation of the assessment by the highest levels of management, and the full support of top management must be given to the assessment. In turn, the objectives, importance, and urgency of the assessment must be articulated and communicated

down the management hierarchy to the managers and performers whose research is to be assessed, and the cooperation of these reviewees must be enlisted at the earliest stages of the assessment;

2. The final assessment product, the audience for the product, and the use to be made of the product by the audience should be considered carefully in the design of the assessment;

3. One person should be assigned to manage the assessment at the earliest stage, and this person should be given full authority and responsibility for the assessment;

4. The assessment manager should report to the highest organizational level possible in order to insure maximum independence from the research units being assessed;

5. The reviewers should be selected to represent a wide variety of viewpoints, in order to address the many different facets of research and its impact [Kostoff, 1988]. These would include bench-level researchers to address the impact of the proposed research on the field itself; broad research managers to address potential impact on allied research fields; technologists to address potential impact on technology and the potential of the research to transition to higher levels of development; systems specialists to address potential impact on systems and hardware; and operational personnel to address the potential impact on downstream organizational operations. The reviewers should be independent of the research units being evaluated, and independent of the assessing organization where possible. The objectives of, and constraints on (if any), the assessment should be communicated to the reviewers at the initial contact;

6. Maximum background material describing the research to be assessed, related research and technology development sponsored by external organizations, the organization structure, and other factors pertinent to the assessment, should be provided to the reviewers as early as possible before the review. This will allow the reviewers and presenters to use their time most productively during the review;

7. Recommendations resulting from the assessment should be tracked to insure that they are considered and implemented, where appropriate. For research programs, planning, execution, and review are linked intimately. Feedback from the review outcomes to planning for the next cycle should be tracked to insure that the review/planning coupling is operable.

Evaluations should be performed at three levels of resolution in the organization:

1. The highest level would be an annual <u>corporate level review</u> of how the organization performs research. If the organization has a separate research unit, then the unit should be evaluated as an integrated whole. If research is vertically integrated with development, then the research should preferably be evaluated as part of a total organization R&D review. The charter of this highest level assessment would be to review, at the corporate level, general policy, organization, budget, and programs (e.g., NIST, [1991]). Total inputs and outputs, including integrated bibliometric indicators, would be examined. Overall research

management processes would be examined, such as selection, execution, review, and technology transfer of research. The overall investment strategy would be evaluated, and would include different perspectives of the program, such as technical discipline, performer, and end use allocation. The integration of the research objectives with the larger organization objectives would be assessed. The evaluators would include, but not be limited to, representatives of the stakeholder, customer, and user community whose potential conflicts with the organization are minimal.

2. The second level would be trienniel peer review of a discipline or management unit at the program level (e.g., Kostoff, [1988, 1995a]), where a program is defined as an aggregation of work units (Principal Investigators). If the organization has a separate research unit, then the discipline should be evaluated as an integrated whole. In the nominal review, quality and relevance could be evaluated concurrently. If research is vertically integrated with development, then the research should preferably be evaluated as part of a total vertical structure R&D review. In the nominal vertical structure review, quality and relevance should preferably be evaluated separately. Thus, research evaluation must take into account how research is structured, integrated, and managed within an organization. Research quality criteria should include research merit, research approach, productivity, and team quality. Relevance criteria should include short term impact (transitions and/or utility), long term potential impact, and some estimate of the probability of success of attaining each type of impact. While the emphasis is on peer review, bibliometric and other type of indicators should be utilized to supplement the peer evaluation.

3. The third level would be a minimum of trienniel peer review at the work unit (Principal Investigator) level (e.g., DOE, [1993]). Most of the program level issues described above are applicable and need not be repeated here.

-For each of these three levels of review, the following criteria and issues should be considered during the review as appropriate.

The following criteria and issues should be considered during the review as appropriate.

1. Quality and uniqueness of the work
2. Scientific and technological opportunities in areas of likely organization mission importance
3. Need to establish a balance between revolutionary and evolutionary work
4. Position of the work relative to the forefront of other efforts
5. Responsiveness to present and future organization mission requirements
6. Possibilities of follow-on programs in higher R&D categories
7. Appropriateness of the efforts for organization as opposed to other organizations

8. Coordination with related work in other organizations

The following questions should be asked of organization programs:

1. What is the investment strategy of the larger management unit. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. For each program being reviewed, what is the investment strategy for its thrust areas.
2. What are we trying to do (in a systems concept)?
3. Can specific advantage to the organization be identified if program is successful?
4. How is the system done today and what are the limitations of the current practice?
5. Would the work be supported if it were not already underway?
6. Assuming success, what difference does it make to the user in a mission area content?
7. What is the technical content of the program and how does it fit with other ongoing efforts in academia, industry, organization labs, other labs, etc.?
8. What are the decision milestones of the program?
9. How long will the program take; how much will the program cost; what are the mid-term and final objectives of the program?

PEER REVIEW - SUMMARY AND CONCLUSIONS

Peer review is the most widely used and generally credible method used to assess the impact of research. Much of the criticism of peer review has arisen from misunderstandings of its accuracy resolution as a measuring instrument. While a peer review can gain consensus on the projects and proposals that are either outstanding or poor, there will be differences of opinion on the projects and proposals that cover the much wider middle range. For projects or proposals in this middle range, their fate is somewhat more sensitive to the reviewers selected. If a key purpose of a peer review is to insure that the outstanding projects and proposals are funded or continued, and the poor projects are either terminated or modified strongly, then the capabilities of the peer review instrument are well matched to its requirements.

However, the value of peer review as a predictive tool for assessing the impact of research on an <u>organization's mission</u> (other than research for its own sake) rests on faith more than on hard documented evidence. Also, for serious panel-type peer reviews or mail-type peer reviews, where sufficient expertise is represented on the panels, <u>total real costs will dominate direct costs</u>. The major contributor to total costs is the time of all the players involved in executing the review. With high quality performers and reviewers, time costs are high, and the total review costs can be a non-negligible fraction of total program costs, especially for programs that are people intensive rather than hardware intensive.

The methods that were described include criteria which address

the impact of research on its own and allied fields, as well as on the mission of the sponsoring organization. The most intensive use of peer review appears to be the NSF/NIH processes for assessing proposals, the DOE review of the BES program at the principal investigator level, and the NAS annual review of NIST. Nearer-term research impacts typically play a more important role in the review outcome than longer-term impacts, but do not have quite the importance of team quality, research approach, or the research merit. A minimal set of review criteria should include team quality, research merit, research approach, and a criterion related to longer-term relevance to the organization's mission. More important than the criteria is the dedication of an organization's management to the highest quality objective review, and the associated emplacement of rewards and incentives to encourage quality reviews.

IV-B. SEMI-QUANTITATIVE METHODS

BACKGROUND AND OVERVIEW

In the evaluation of research impact, a spectrum of approaches may be considered [Wirt, 1974; Salasin, 1980; Logsdon, 1985; Kerpelman, 1985; OTA, 1986; Luukkonen-Gronow, 1987; Averch, 1990; Hall, 1990; Johnston, 1990; OTA, 1991; Kostoff, 1992a, 1993b]. At one end of the spectrum are the subjective, essentially non-quantitative approaches, of which peer review is the prototype [Chubin, 1994, 1990; Cozzens, 1987; DOE, 1982, 1991; Frazier, 1987; Johnston, 1990; Kerpelman, 1985; Kostoff, 1988; Logsdon, 1985; Luukkonen-Gronow, 1987; Ormala, 1989; OTA, 1986; Salasin, 1980]. At the other end of the spectrum are the mainly quantitative approaches, such as evaluative bibliometrics and cost-benefit [Carpenter, 1980; King, 1987; MacRoberts, 1989; Mansfield, 1991; Miller, 1992; Narin, 1976, 1987a, 1987b; White, 1989]. In between are what can be termed semi-quantitative approaches [Kostoff, 1992a, 1992b, 1993d, 1994d, 1994j].

These semi-quantitative methods make little use of mathematical tools but draw on documented approaches and results wherever possible. They have limited credibility in the analytic community, since the selection of innovations to be analyzed tends to be arbitrary rather than mathematically rigorous, and they are viewed more as anecdotal approaches than serious technical approaches. Nevertheless, in practice, some of these approaches (namely, studies of accomplishments resulting from sponsored research programs, or studies of systems and the research products which were eventually converted and incorporated into those systems) are widely used by the research sponsoring organizations.

Three types of semi-quantitative methods used by the Federal government in RIA are presented. These include the classic retrospective method (Project Hindsight), another retrospective approach (Project TRACES and follow-ons), and accomplishments books used by selected research sponsoring organizations (Office of Naval Research, Air Force Office of Scientific Research, Department of

Energy Office of Health and Environmental Research, Department of Energy High Energy Physics Program, Defense Advanced Research Projects Agency). The strengths and weaknesses of each approach are discussed. One goal of all the studies presented was to identify the products of research and some of their impacts. In addition, the Hindsight, TRACES, and ARPA studies tried to identify factors which influenced the productivity and impact of research. The following general conclusions about the role and impact of basic research were reached:

1. The majority of basic research events which directly impacted technologies or systems were non-mission oriented and occurred many decades before the technology or system emerged;
2. The cumulative indirect impacts of basic research were not accounted for by any of the retrospective approaches published;
3. An advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur;
4. Allocation of benefits among researchers, organizations, and funding agencies to determine economic returns from basic research is very difficult and arbitrary, especially at the micro level.

PROJECT HINDSIGHT

Project Hindsight was established by the Defense Department in 1965 to identify those management factors important in assuring that research and technology programs are productive and that program results are used. It also attempted to measure the overall increase in cost-effectiveness in the current generation of weapons systems compared with that of their predecessors assignable to any part of the Defense Department's investment in research and science and technology [DOD, 1969].

The approach taken in Project Hindsight was retrospective. Twenty arbitrarily-selected recent weapons systems and major military equipments were analyzed by (mainly DOD in-house) teams of technical specialists. Their task was to identify applications of science and technology that were not utilized in predecessor military systems designed to meet roughly the same requirements. The evolution of the new technology represented in each system was traced back in time to critical points called "research or exploratory development (RXD) Events". The RXD Event was the basic quantifying unit in the study and was defined as the occurrence of a novel idea and the subsequent scientific and engineering activity in which the idea was examined or tested. There could be one or two RXD Events, or an extended chain of them, culminating in a device or component found in a particular system.

The teams of specialists identified 710 unique RXD Events, conducted the historical traces, and described and documented the related activities in terms of the differential amount of knowledge that accounted in part for the increased cost-effectiveness of the systems analyzed (compared with their predecessors). Project Hindsight concentrated only on the post World War II contributions

of science and technology on the selected systems. Each study team was allowed about three months to complete its research on each system.

In treating the sciences, Hindsight distinguished (1) the basic research done to solve a specific assigned problem from (2) the basic research done to expand the frontiers of scientific knowledge. These were categorized as directed and undirected basic research, respectively. It was found that RXD Events from the directed basic research category emerged in systems development approximately nine years following their conception, while it took twenty or more years for some events from the undirected category to impact development. The Hindsight study did not treat in any depth the contribution from undirected basic research, since many of those events predated the time span of the project [DOD, 1969].

Before discussing the methodology further, some of the critical findings will be summarized. The identification of the RXDs was found to be fairly simple, and time limitations permitted only a fraction to be uncovered and examined. The results of research in science were most frequently exploited when the investigator responded to recognized needs of the engineering community. A high probability of utilization involved awareness on the part of the scientist concerning who in the engineering community needed the knowledge, and on the part of the interested engineers as to which specific scientist was working on the problem.

The greatest identified payoff in terms of ideas leading to enhanced weapons systems resulted from research in technology - and then, where the research scientist or engineer was intimately aware of problems of the applications engineer. The real difference in performance between a weapon system and its predecessor was usually not the consequence of one, two, or three scientific advances or technological capabilities but was the synergistic effect of 100, 200, or 300 advances, each of which alone was relatively insignificant. These hundreds of diverse advances must then be fitted and adjusted for a unified operational weapon system. The characteristics of each advance must be carefully interfaced with those of other advances. Project Hindsight data showed that systems applications, rather than new science, inspired science and technology for advanced systems.

While criticisms of a project of the complexity and scope of Hindsight are possible, Hindsight was a reasonable first step in assessing the impact of applied research and technology development on weapons systems. The question is whether the Hindsight approach and conclusions were appropriate for evaluating the impact of basic research on weapons systems, or whether the study groundrules and constraints contained built-in biases against basic research.

The most obvious limitation of Hindsight relating to basic research is the time frame. A reading of the Hindsight report Appendices shows that most of the RXDs occurred in the 1950s, with few in the '40s and '60s. Since many fundamental research projects could require more than two decades for their results to impact systems (especially two decades ago when dissemination of results

did not have the benefit of today's communication channels and systems), the cut-off on time span could have precluded the inclusion of research impacts. If an updated Hindsight study were performed, the time problem could be alleviated by increasing the retrospective time span allowed. Thus, the time span problem is not a flaw or limitation of the generic retrospective process, but rather is associated with the particular Hindsight implementation.

A more serious limitation relates to the RXD approach. The RXDs are identifiable advances which draw upon the pool of technical knowledge in existence at that time. But the pool of knowledge is continually increasing, and the components of this pool are highly interrelated, both directly and indirectly. For example, advances in basic materials understanding may be dependent upon advances in physics, chemistry, mathematics, computer technology, laser technology, computer algorithms, etc. Some of these impacts are direct, most are indirect.

Thus, any RXD could theoretically be shown to be impacted directly or indirectly by small (or in some cases large) advances in the component basic research of the knowledge pool. While the direct or indirect impact of any one basic research component on any one RXD may be small (if it were large and within the time span, it would have been identified as an RXD), the total direct and indirect impact of this basic research component on **all** the RXDs may not be small. **These cumulative indirect and direct impacts of basic research are not accounted for by the Hindsight methodology, and in fact are not taken into account by any of the retrospective approaches published or in use today. A study [Kostoff, 1991c, 1992a, 1994i, section on Network Modeling for Direct/Indirect Impacts later in Handbook] which examined impacts of research on other research and technology through direct and indirect paths using a network approach showed that the indirect impacts of fundamental research can be very large in a cumulative sense**. For Hindsight, the indirect impacts would have been even larger if the actual larger number of RXDs had been examined.

The Hindsight conclusions relative to the impact of basic research have to be seen in perspective. The conclusion to be drawn from the study is that fundamental research had little direct impact on selected weapons systems (whose degree of design conservatism, which could impact implementation speed of revolutionary concepts, was not stated or evaluated) in a time period threshold two decades before weapon system implementation. Had the time period threshold been expanded, and indirect impacts of the basic research been incorporated into the study, then a conclusion could have been drawn about the total impact of the basic research **on weapon systems**. However, had the question about impact been raised from the basic research component viewpoint, and an appropriate study been done (of which Hindsight would have been one part), then conclusions could have been drawn about **total impact of the basic research component on all technology and systems, of which the Hindsight weapons systems were one part.**

TRACES

The Original TRACES Study

In 1967, The National Science Foundation (NSF) instituted a study to trace retrospectively key events which had led to a number of major technological innovations (Technology in Retrospect and Critical Events in Science - TRACES). One goal was to provide more specific information on the role of the various mechanisms, institutions, and types of R&D activity required for successful technological innovation [IITRI, 1968].

The study performers, Illinois Institute of Technology Research Institute (IITRI), chose, in their view, a representative cross section of research and development for study and treated all cases uniformly. The five innovations selected were: Magnetic Ferrites, Video Tape Recorder, Oral Contraceptive Pill, Electron Microscope, and Matrix Isolation. Key 'events' in the research and development history of each innovation were identified, an 'event' being defined as the point at which a published paper, presentation, or reference to the research was made. The research and development activities on the five tracings were grouped by category of research (mission, non-mission), type of institution, date of event, etc., to bring out some of the factors which entered into the transition from non-mission research to innovation.

The study showed that non-mission research provided the origins from which science and technology could advance toward innovations. It also showed that, of the 341 key research and development events judged to be important to the evaluation of innovation, approximately 70 percent were non-mission research, 20 percent mission-oriented research, and 10 percent development and application. The number of non-mission events peaked significantly between the twentieth and thirtieth year prior to an innovation, while mission-oriented research events and those in the development and application area peaked during the decade preceding innovation. For the cases studied, the average time from conception to demonstration of an innovation was nine years.

Ten years prior to an innovation, i.e., shortly before conception, approximately 90 percent of the non-mission research had been accomplished; most non-mission research appeared **completed prior to the conception** of the innovation to which it would ultimately contribute. The tracings also revealed cases in which mission-oriented research or development efforts elicited later non-mission research which often was found to be crucial to the ultimate innovation.

There are a number of interesting comparisons to be made between TRACES and Hindsight. First, the TRACES time frame extends back sufficiently far to include many basic research results, while the Hindsight time span was able to include most development events, but excluded most basic research results. Hindsight traced the impacts on weapons systems, whereas TRACES examined the impact on single technologies. Thus, the Hindsight starting point, a weapons system, is one level higher (consists of many single technologies) than the TRACES starting point. Coupled with the fact that the Hindsight weapons systems had, on average, 35 events, and the TRACES innovations had, on average, 70 events, it is not

surprising that the Hindsight events tended to be applied research or technology advances, whereas the TRACES events tended to be more basic research. In neither case were indirect impacts of basic research given formal credit, although the TRACES study did allude to non-mission research as "a fund of knowledge against which withdrawals can be made to achieve innovation at a rate satisfactory to society" [IITRI, 1968].

TRACES Follow-on Study

In a follow-on study to TRACES, the NSF sponsored Battelle-Columbus Laboratories to perform a case study examination of the process and mechanism of technological innovation [Battelle, 1973]. For each of the ten innovations studied (Heart Pacemaker, Hybrid Corn, Hybrid Small Grains, Green Revolution Wheat, Electrophotography, Input-Output Economic Analysis, Organophosphorus Insecticides, Oral Contraceptives, Magnetic Ferrites, Video Tape Recorder), the significant events (important activity in the history of an innovation) and decisive events (a significant event which provides a major and essential impetus to the innovation) which contributed to the innovation were identified. The influence of various exogenous factors on the decisive events was determined, and several important characteristics of the innovative process as a whole were obtained.

Based on frequency of occurrence of the highest rankings of the exogenous factors on the decisive events, the following rankings of importance were obtained:

1. Recognition of Technical Opportunity (motivation of the timely improvement of an existing product or process) ranked first among the exogenous factors;
2. Recognition of the Need (motivation for solving the problem or meeting **the** need satisfied by the eventual innovation, rather than **any** technological need) ranked second;
3. Technical Entrepreneur (an individual within the performing organization who champions a scientific or technical activity) ranked third;
4. Certain institutional factors, such as Internal R&D Management, Availability of Funding, Management Venture Decision, etc., ranked fourth collectively, indicating the importance of the institutional environment to the innovative process.

Based on examination of characteristics of the case histories as a whole, rather than focusing on decisive events as above, the following generalizations were drawn:

1. The technical entrepreneur is a characteristic important in nine of the ten innovations, and is a major driving force in the innovative process;
2. Early recognition of the need was characteristic of the history of nine of the innovations;
3. Government funding was instrumental in direct support of seven of the innovations. More generally, availability of

financial support, from whatever source, emerged as an important feature of the innovative process;

4. The occurrence of an unplanned confluence of technology was characteristic of six of the innovations. Confluence of technology occurred for the other four innovations as well, but as a result of deliberate planning, rather than by accident;

5. Most of the innovations originated outside the organization that developed them;

6. Additional supporting inventions were required during the development effort for all the innovations studied to arrive at a product with consumer acceptance.

Over the full time span of the innovation, nearly 34 percent of the significant events were non-mission oriented research (NMOR), 38 percent were mission oriented research (MOR), 26 percent were developmental, and a few percent were nontechnical. Of the total events in the period prior to conception of the innovative idea, over half were NMOR and one third MOR. In the bounded interval between first conception and first realization, 16 percent were NMOR, with the remainder split among MOR (43 percent), development (38 percent), and nontechnical events (3 percent). Many of the NMOR events in the bounded interval were in the nature of feedback or spinoff basic research prompted by the innovation. In the post-innovation period, when diffusion and improvement take place, 10 percent of the events were NMOR, 39 percent were MOR, and 45 percent were development.

The number of NMOR events peaked in the period three to four decades prior to the culmination of the innovation, whereas the number of MOR and development events peaked in the decade preceding the date of innovation. Half of the NMOR events occurred 30 years preceding innovation; half of the MOR events occurred in the 15 years prior to innovation, and half the developmental effort took place within the ten years preceding innovation.

The study authors recognized, to some degree, that the focus on specific events did not allow sufficient credit to be allocated to the indirect impacts of research. As they stated: "this kind of analysis tends to underplay the role of NMOR in the innovative process, since it does not portray the importance of the general background of science necessary for the other categories of technical events. For example, MOR and developmental activities in insecticides would have been impossible without the antecedent totality of organic chemistry. Similarly, research on contraception depended on the basic science background of reproductive biology. As a further example, in the case involving grain improvement, Hybrid Small Grains and Green Revolution Wheat show a low percentage of NMOR events (20 percent), but these percentages would be higher if the early NMOR events credited to Hybrid Corn were also counted in their totals". They correctly identified the absence of recognition given to specific supporting fields of research. However, they did not identify or attempt to account for the impacts of the fundamental research from many fields which resulted in the instrumentation, theoretical, and

computational capabilities necessary for these supporting research fields to advance.

A Recent TRACES Study

In the mid-1980s, the National Cancer Institute (NCI) initiated an assessment to determine the effectiveness of different research settings or support mechanisms in bringing about important advances in cancer research. The approach taken was analogous in concept to the initial TRACES study, with the addition of citation analyses to provide an independent measure of the impact of the Trace papers (papers associated with each key 'event'), and by adding control sets of papers.

Thirteen important 'Advances' (key 'events') in cancer research were defined by a senior advisory panel of experts, and the key papers associated with these 'Advances' and in the historiographic research streams were identified. Both the support source and the institutional setting of the papers were analyzed. In addition to the Trace papers, three other sets of papers were developed to serve as comparison sets whose properties were contrasted with the Trace papers.

The study concluded that all the research settings, and all the support mechanisms (small and large grants, contracts, intramural NCI, etc.) contributed significantly to the 'Advances', with no single mechanism or setting represented disproportionately. More specifically, NCI provided 37 per cent of the acknowledged support for the Trace papers, there was a large amount of co-operative, multi-sponsor support for the Trace papers, and papers on the Traces, whatever the support mechanism, were extremely highly cited - eight times as frequently as expected [Narin, 1989].

While indirect impacts of research on the 'Advances' were not a goal of this study and were not evaluated, the additional methodology (mainly citation and co-citation analysis) used in performing the latest Traces incarnation could shed some light on indirect impacts. For example, one of the control sets of papers used in the study was termed Augmentation papers and consisted of closely related contemporaneous papers cited with the Traces papers and identified through co-citation techniques. Another of the control sets was called Science base and consisted of papers cited by the Trace papers, representing the precursor knowledge upon which the selected major' Advance' was dependent.

These two sets of papers provided some idea of the **direct impact** of other science fields on the cancer fields of interest ('Advances'). If citation and co-citation analysis were done on the Augmentation papers and the Science Base papers, combined with word frequency and co-word analyses of these paper sets [Kostoff, 1991d, 1992a, 1993c, 1993e, 1993f, 1994h], and the process repeated a few times, then many of the pathways through which indirect impacts on the 'Advances' occur could be identified, and the magnitude of the impacts perhaps quantified to some degree. The amount of data and analyses required would be large, but based on the results and conclusions of a recent network-based approach to evaluating indirect impact of research [Kostoff, 1991c, 1992a,

1994i], the computational/ analytical problem is of necessity large because of the potentially large number of pathways through which direct and indirect impacts of research can occur.

ACCOMPLISHMENTS BOOKS

Background

Semi-quantitative methods, such as Hindsight and TRACES, require substantial commitments of people, time, and dollars. Because of the large resource requirements, these types of studies are performed relatively infrequently. A more common vehicle used by Federal research sponsoring organizations to display the impacts of funded research on advancement of science, actual or potential impacts on advancement of allied science or technology, and potential impacts on the organization's mission is the accomplishments book. This type of document tends to present descriptions of selected scientific accomplishments in sufficient detail for the reader to understand the science that was accomplished, and have some idea of the potential importance of the research to mission, technology, and perhaps the commercial sector. The accomplishments books make no pretenses about being all-inclusive, nor do they usually include quantitative estimates of impact. The accomplishments are drawn from the different disciplines funded by the organization, and are meant to be portrayed as representative of the breadth of activity. A few of these books are described briefly; the books selected should be viewed as representative of the genre.

Office of Naval Research (ONR)

Periodically, the ONR produces a book of significant accomplishments [e.g., ONR, 1992]. The accomplishments are categorized into four major areas, reflecting the ONR Core Competency structure: Ocean Sciences, Advanced Materials, Information Sciences, Sustaining Program. Thirty-one accomplishments are described in the most recent incarnation, one per page, including topics such as New Gulf Stream Variability Model, New Semiconductor Materials for At-Sea Computers, Classifying Underwater Objects, and Merging Living Cells with Electronics. The reader of this document receives a synopsis of the many areas in which ONR is involved, how these areas can impact the Navy and Marine Corps potentially, and the types of people and organizations performing the research.

Air Force Office of Scientific Research (AFOSR)

The AFOSR accomplishments book is similar in structure and spirit to that of ONR. In one incarnation [AFOSR, 1989], the accomplishments were divided among the six technical disciplines which reflect the AFOSR management structure: Aerospace Sciences, Chemical and Atmospheric Sciences, Electronic and Material Sciences, Life Sciences, Mathematical and Information Sciences, and Physical and Geophysical Sciences. Twenty-five accomplishments were described, with more or less equal representation from each of

the six disciplines. As in the ONR book, no quantification of impact was attempted.

Department Of Energy (DOE), Office of Health and Environmental Research (OHER)

A somewhat different type of accomplishments book was generated by the DOE, Office of Energy Research, for one of its component organizations, OHER [DOE, 1983, 1986]. The approach taken was to describe the 40-year history of OHER, and present selected accomplishments in different research areas from different points in time. This technique allowed impacts and benefits of the research to be tracked through time, and in some cases to be quantified as well.

Costs of these programs, or subprograms, were not provided, and it is therefore difficult to relate the benefits, where stated, to the costs. Some of the benefits, such as an improved knowledge base on which to set health regulatory standards, would be extremely difficult to quantify. In some cases, the report does attempt this quantification. For example, in discussing radiation standards, the report states: "More stringent standards, which might have been necessary in the absence of knowledge gained through the research program, could have easily cost electric power consumers an additional $2 billion annually" [DOE, 1983].

Other examples of research accomplishments probably not amenable to quantification are presented throughout the report, such as development of a capability to predict the travel and dispersion of hazardous substances (space debris, nuclear weapons tests byproducts) released into the atmosphere. No numbers are associated with this accomplishment.

There are examples of hardware, or products, which resulted from the research, and quantification is applied to some of these accomplishments. The flow cytometer and centrifugal fast analyzer (CFA) were developed to help search for radiation effects on humans. These have evolved into commercial products, and the quantified benefit given in the report is: "About 10,000 units are in worldwide use". In the second volume [DOE, 1986], benefits for the centrifugal fast analyzer are stated as: "estimated savings of $30 to $90 million/year." The high resolution gamma ray spectrometer was developed to distinguish between radioactive elements with emissions of similar energies. Today, it is broadly used to monitor the environment and in many research applications as well, and the quantified benefit in the first report is: "Based on the value of rapid analysis as compared with slower alternatives, the benefit to nuclear plant operation alone is estimated to be $20 million annually".

A detailed reading of this document uncovers the difficulties of trying to identify, assign, and quantify costs and benefits of basic research. As TRACES and other similar studies have shown, the chain of events leading to an innovation is long and broad. Many researchers over many years have been involved in the chain, and many funding agencies, some simultaneously with the same researchers, may have been involved. How should costs and benefits

be allocated under such circumstances?

For example, in volume 2 [DOE, 1986], the 'original' funding for the centrifugal fast analyzer project was shared by the Atomic Energy Commission (AEC) and the National Institutes of Health (NIH), and later funding was provided by the National Aeronautics and Space Administration (NASA) for a zero-G variant. **How should credit for the benefits be shared among these three agencies? And what about all the fundamental research that led up to the invention of the CFA; how should the benefits be allocated to the researchers and funding agencies that participated?**

Again, in volume 2, in the section about Iodine-131 therapy for hyperthyroidism, it is stated that the basic application of Iodine-131 to toxic goiter diseases was developed from 1939-1941. The initial AEC involvement is reported in 1946 (when the AEC was formed) when Iodine-131 from nuclear reactor fission products was shipped from Oak Ridge National Laboratories. The report states that "total estimated savings in treatment cost because of the use of Iodine-131 could be as high as $280 million/year". **How much of this amount should be credited to AEC research? All $280M? None (the initial innovation was completed before the AEC was formed)? Only the portion of the total benefits resulting from cheaper isotopes? These are difficult questions and are endemic to any study of basic research which tries to assign costs and benefits to particular innovations.**

DOE High Energy Physics Program

Another historiographic-based approach to describing program accomplishments is that used by the DOE High Energy Physics Program [DOE, 1990]. The history and interrelatedness of the diverse elements of the program, followed by the wider applications of high energy physics, constitute this accomplishments book. One chapter is devoted to the impact of knowledge gained from high energy physics on the fields of astrophysics and cosmology. No quantification is attempted, since improved understanding of the universe does not lend itself to that type of analysis.

More practical benefits resulting from better understanding of high energy beams, as well as resulting from the devices, instruments, and technologies that were developed to perform high energy physics research, are presented at the end of the report. Here, the different applications are described (tumor treatment, medical diagnosis, ion implantation, materials research, x-ray lithography, radioisotope production, superconducting magnets, klystrons, etc), but no quantification is attempted.

Advanced Research Projects Agency (ARPA) Technical Accomplishments

The ARPA was established in 1958 in response to Sputnik. ARPA's initial primary focuses were:

1. The 'Presidential Issues' of space;
2. Ballistic Missile Defense (Project DEFENDER) and nuclear test detection (VELA);
3. Avoiding future 'Sputniks' as its broader overall charter.

Over its lifetime, as its mission has been redefined and refocused, it has sponsored a wide variety of thrust areas, including the following major areas:

1. Defense Manufacturing;
2. Nuclear Test Monitoring;
3. Naval Technologies;
4. Materials and Components;
5. Sensors and Surveillance;
6. Command, Control, and Communications;
7. Information Processing;
8. Ground Systems and Weapons;
9. Air Systems;
10. AGILE (counter-insurgency R&D);
11. High Energy Systems;
12. DEFENDER and Space Defense; Space Systems.

In the early 1990s, the Institute for Defense Analysis (IDA) produced a massive three-volume set describing the accomplishments of ARPA [IDA, 1991]. Of the hundreds of projects and programs funded by ARPA over its then (1988) 30 year lifetime, 49 were selected and studied in detail. Two criteria were used by the IDA project team and the ARPA management collectively in selecting projects/ programs to be studied: 1) the importance of the projects, judged on the basis of evidence in attestation and documentation; and 2) the expected availability of data. The focus of the 49 retrospectives documented was:

1. what were the origins of each project or program;
2. what did ARPA itself do;
3. what was the result, impact, and effect of the work ARPA supported?

The structure of the description of each accomplishment was:

1. a brief overview of the history and accomplishment;
2. a detailed technical history of the project;
3. observations on its success.

At the end of each project description was a time evolution chart of the project. The actions/ achievements of the different organizations involved in the project's evolution (preceding, paralleling, and succeeding ARPA's involvement) were shown as a function of time. The main ARPA involvement (ARPA project track) was highlighted, related ARPA actions or ARPA influence were shown, ARPA technology transfer was shown, and related actions by other groups was shown. At the end of each project writeup, the ARPA costs over the project life (where known) were identified and some estimate of the dollar benefits (where possible) was presented.

In general, the outcomes of ARPA projects have included:

1. development or initial demonstrations of new technology;
2. demonstrations of new applications of known technology;
3. development and demonstration of new concepts of experimentation or operation;
4. integration of diverse technologies into new system concepts for the first time.

Often, more than one of these kinds of payoff could be achieved by the same project. Most of the projects supported were technology or systems development rather than basic research, but many were fed by basic as well as applied research. The qualities of ARPA-supported programs and projects that contributed to success can be summarized:

1. A need existed for what the output could do;
2. There was a strong commitment by individuals to a concept;
3. Bright and imaginative individuals were given the opportunity to pursue ideas with minimal bureaucratic encumbrance;
4. There was an ongoing stream of technical developments and evolution;
5. ARPA management gave strong, top-level management support;
6. There was explicit effort, taken early, to improve acceptance by the user community.

The degree of success and impact is more difficult to measure. In some cases, the results of projects or programs, usually expressed in hardware, were transferred fully to a user. Other transfers have been partial, limited, or indirect. Given the multifaceted nature of some projects, several of these characteristics apply to the same project. Finally, success in transferring the hardware or knowledge gained in ARPA programs often depends on timing and the relationship to other events and programs. The report provides an excellent example of the impact of exogenous events on the fate of SLCSAT, a project which has had some successful technology validation of satellite-submarine laser communication. Whether the Navy adopts the system for communication with submarines will depend on the Navy's concepts of submarine operation in the new tactical and strategic world that is emerging in the aftermath of the cold war and the budget available for such purposes in the new environment.

The impacts of the more fundamental ARPA areas of support, such as Materials Sciences and Information Processing, are more difficult to measure than impacts of the development-oriented projects, where transition to a defined user is somewhat clearer. The report defines ARPA's impact in these technology base areas as having stimulated an infrastructure and new disciplines. It identifies programs established at universities, interdisciplinary efforts initiated, projects in fundamental technologies accelerated by ARPA funding, and hardware/ software products which resulted.

Similar to the other semiquantitative approaches described above, the IDA report does not (in the author's opinion) account sufficiently for benefits resulting from indirect impacts of

research. In the time evolution charts at the end of each project writeup, a few critical events/ technologies which preceded the ARPA involvement are shown, and then the ARPA contribution is highlighted. The existing pool of scientific and technological knowledge, which ARPA exploited very productively, was developed over many years by many diverse organizations and was a necessary condition for ARPA to achieve its successes and impacts. The people and organizations who developed this base of technology complemented the ARPA effort, and should share in the benefits.

One of the major impacts of ARPA support, which could be quantified by relating costs to benefits, is that <u>projects were brought to fruition earlier than they would have been without ARPA support</u>. Areas such as gallium arsenide semiconductors, computer architectures (RISC, systolic array, symbolic processing, parallel processing, neural networks), the ADA language, for example, were accelerated greatly because of ARPA's involvement and support. Future ARPA accomplishments reports could relate the ARPA program (or specific project) expenditures (in a discounted sense) to the earlier realization of benefits (in a discounted sense) due to ARPA support to provide additional measures of the effectiveness of ARPA's funding [Mansfield, 1991].

PRINCIPLES OF HIGH QUALITY RETROSPECTIVE STUDIES

A careful reading of the above, and many other, retrospective studies shows that it is difficult to assess study quality on the sole basis of the published report. However, principles for high quality retrospective studies have been generated by the author by integrating the contents of these reports with personal experience in conducting retrospective studies. A high quality retrospective study is an accurate reflection of the evolution and relation of all critical sciences and technologies which resulted in the technology of present interest. Thus, a high quality retrospective study is analogous to a high resolution picture of the evolving relationships among science and technology areas related critically to the focal technology, and incorporates especially the concepts of awareness, coordination, and completeness. More specific requirements, or underlying principles, necessary for a high quality retrospective study can be formulated as follows.

The most important factor is the commitment of the retrospective study organization's senior management to high-quality retrospective studies, and the associated emplacement of rewards and incentives to encourage such retrospective studies.

The second most important factor is the retrospective study manager's motivation to construct a technically credible and visionary retrospective study. The retrospective study manager sets the boundary conditions and constraints on the retrospective study scope, structures the working groups, and selects the final retrospective study elements from a myriad of inputs. In some organizations, the retrospective study manager has the latitude to select the complete retrospective study process and criteria, and in all organizations presently has the latitude to

select the retrospective study contributing technical experts by a non-random process. If the retrospective study manager does not follow, either consciously or subconsciously, the highest standards in selecting these experts, the retrospective study's final form could be substantially determined even before the study process begins.

The third most important factor consists of the study experts' competence and objectivity. Each expert should be technically competent in his subject area, and the competence of the total retrospective study development team should cover the multiple research and technology areas critically related to the science or technology area of present interest. In addition, the team's focus should not be limited to disciplines related only to the focal technology area (which tends to reinforce the status quo and further promulgate development along very narrow lines), but should be broadened to disciplines and technologies well beyond the focal technology.

For retrospective studies which will be used as a basis for comparison of science and technology programs or projects, the fourth most important factor is normalization and standardization across different retrospective studies, study component teams, and science and technology areas. For science and technology areas which have some similarity, use of common experts (on the study teams) with broad backgrounds which overlap the disciplines can provide some degree of standardization. For very disparate science and technology areas, some allowances need to be made for the relative strategic value of each discipline to the organization, and arbitrary corrections applied for benefit estimation differences and biases. Even in this case of disparate disciplines, some normalization is possible by having some common team members with broad backgrounds contributing to the retrospective studies for diverse programs and projects.

The fifth most important factor is criteria for retrospective study component selection. Since retrospective studies tend to focus on the critical science and technology events which led to successful technologies/ systems, the definition of criteria for 'successful' and 'critical' is of utmost importance for establishing the credibility of the retrospective study.

A factor of equal importance is reliability or repeatibility. To what degree would a retrospective study be replicated if a completely different team were involved in its construction? If each team were to construct a completely different retrospective study for the same topic, then what meaning or credibility or value can be assigned to any retrospective study? To minimize repeatibility problems, a reasonably sizeable segment of the competent technical community should be involved in the construction and review of the the retrospective study. For government-constructed retrospective studies, this does not present a conceptual problem, although it might present a logistics problem for sufficiently large community involvement. For industry-constructed retrospective studies, where proprietary problems could arise if the external community becomes involved, the participation

may have to be limited. The recommendation should be re-interpreted as 'to the degree possible within organizational constraints'.

A sixth critical factor for quality retrospective studies is cost. The true total costs of developing a high quality retrospective study with substantial community input can be considerable, but tend to be understated. For high quality retrospective studies, where sufficient expertise is represented on the study team, the major contributor to total costs is the time of all the individuals involved in developing and reviewing the retrospective study. With high quality personnel involved in the development and review process, time costs are high, and the total study costs can be non-negligible. Costs should not be neglected in designing a high quality retrospective study development process.

The final critical factor, and perhaps the foundational factor, in high quality retrospective study development is the maintenance of high ethical standards throughout the process. There is a plethora of potential ethical issues, because there is an inherent bias/ conflict of interest in the process when real experts are desired as retrospective study performers and reviewers. The retrospective study development managers need to be vigilant for undue signs of distortion aimed at personal gain.

SEMI-QUANTITATIVE METHODS - SUMMARY AND CONCLUSIONS

A variety of approaches were presented which showed different types of impacts of research, but little or no quantification of impact was performed. Hindsight, TRACES, and, to some degree, the DARPA accomplishments books had some similar themes. All these methods used a historiographic approach, looked for significant research or development events in the metamorphosis of research programs in their evolution to products, and attempted to convince the reader that: (1) the significant research and exploratory development events in the development of the product or process were the ones identified; (2) typically, the organization sponsoring the study was responsible for some of the (critical) significant events; (3) the final product or process to which these events contributed was important; and (4) while the costs of the research and development were not quantified, and the benefits (typically) were not quantified, the research and development were worth the cost.

As the historiographic analyses (Hindsight/ TRACES) of a technology or system have shown, if the time interval in which the antecedent critical events occur is arbitrarily truncated, as in the two-decade time interval Hindsight case, the impacts of basic research on the technology or system will not be given adequate recognition. As Hindsight and the different TRACES studies have shown, the number of mission oriented research events peaks about a decade before the technology innovation. However, these studies have also shown that the number of non-mission oriented research events peaks about three decades before the technology innovation,

and eight or nine decades, or more, may be necessary in some cases to recognize the original critical antecedent events. Over a long time interval, the majority of key R&D events tend to be non-mission oriented. Thus, future studies of this type should allow time intervals of many decades to insure that critical non-mission oriented research events are captured.

Even in those cases when an adequate time interval was used, and critical non-mission oriented events were identified, the cumulative indirect impacts of basic research were not accounted for by any of the retrospective approaches published or in use today. A recent study [Kostoff, 1991c, 1992a, 1994i] which examined impacts of research on other research and technology through direct and indirect paths using a network approach showed that the indirect impacts of fundamental research can be very large in a cumulative sense. Future retrospective studies should devote more effort to identifying indirect impacts of research to enhance their credibility. While indirect impacts of research are much more difficult to identify than direct impacts, and the data gathering effort is much larger and more complex, neglect of indirect impacts skews the results and conclusions relative to the value of basic research significantly. Use of some of the advanced computer-based technologies available today, such as the network approach referenced above or citation analysis [Narin, 1989], could identify many of the pathways of the indirect impacts of research.

A detailed reading of some of the studies which attempted to incorporate economic quantification showed the difficulties of trying to identify, assign, and quantify costs and benefits of basic research, especially at a micro level. As TRACES and other similar studies have shown, the chain of events leading to an innovation is long and broad. Many researchers over many years have been involved in the chain, and many funding agencies, some simultaneously with the same researchers, may have been involved. The allocation of costs and benefits under such circumstances is a very difficult and highly arbitrary process. The allocation problem is reduced, but not eliminated, when the analysis is applied at the macro level (integrating across individual researchers, organizations, etc.).

Six critical conditions for innovation were identified implicitly and explicitly through analysis of these retrospective studies. The most important condition from the author's perspective implicitly appears to be **the existence of a broad pool of knowledge which minimizes critical path obstacles** and can be exploited for development purposes. The time required to overcome deficiencies in the knowledge pool is the pacing item to initiate the research exploitation process. This condition is followed in importance, from the author's perspective, by a **technical entreprenuer who sees the technical opportunity and recognizes the need for innovation**, and who is willing to champion the concept for long time periods, if necessary. **While the technical entrepreneur was viewed by some of the studies as most important to the innovative process, it does not appear (to the author) to be the critical path factor. Examination of the historiographic tracings**

which display the significant events chronologically for each of the innovations shows that an advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur. The entrepreneur can be viewed as an individual or group with the vision and ability to both recognize the downstream applications (need) for the research and to assimilate and/ or enhance this diverse information and exploit it for further development. However, once this pool of knowledge exists, there are many persons or groups with capability to exploit the information, and thus the real critical path to the innovation is more likely the knowledge pool than any particular entrepreneur. The entrepreneurs listed in the studies undoubtedly accelerated the introduction of the innovation, but they were at all times paced by the developmental level of the knowledge pool.

The third most important condition is **early recognition of the need,** coupled with early efforts taken to improve acceptance by the user community. In many cases, these functions will be performed by the entrepreneur. Also valuable for innovation are **strong financial and management support**, and occurrence of an **unplanned confluence of technology** coupled with **many continuing inventions in different areas** to support the innovation.

One goal of all the studies presented was to identify the products of research and some of their impacts. In addition, the studies attempted to identify environmental/ management factors which led to successful research and to rapid conversion of the products of successful research to technology. The Hindsight, TRACES, and DARPA studies tried to identify factors which influenced the productivity and impact of research. The following conclusions about the role and impact of basic research were reached:

1. The majority of basic research events which directly impacted technologies or systems were non-mission oriented and occurred many decades before the technology or system emerged;
2. The cumulative indirect impacts of basic research were not accounted for by any of the retrospective approaches published;
3. An advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur;
4. Allocation of benefits among researchers, organizations, and funding agencies to determine economic returns from basic research is very difficult and arbitrary, especially at the micro level.

A recent workshop on technology transfer validated the conclusions of these classical studies [Isaacs, 1996], at least in the corporate environment. The moderators identified the following success factors:

1) Management and Organizational Infrastructure

a. An organizational model that encourages coordination between research activities and product projects

b. Executive-level commitment to the transfer of ideas from

research groups to development groups

c. Geographic and social proximity between research and development groups

2) Technology Push

a. Research projects that are aligned with corporate strategy

b. Research projects with people highly motivated to see their research transferred into products

c. A high-level visionary who champions bringing the idea to market

d. Readily demonstrable improvements over existing or related products

3) Demand Pull

a. A product group motivated and poised to take the technology

b. A significant customer with a strong need for the technology

c. An involved marketing group that tracks customers' needs and markets the ideas throughout the company

These and similar studies also identified many other factors important in the successful evolution of science to technology. Additional factors include: awareness of ongoing research through diverse information sources; types of cooperative R&D agreements between researchers and developers; intellectual property issues such as disclosure, protection, marketing, negotiating and licensing; Congressional incentives to collaboration; and other legal, financial, cultural, and sociological incentives and roadblocks.

Some personal observations of the value of retrospective studies for accelerating science conversion [Kostoff, 1997j], based on both the published studies and the author's experiences with conversion of science to technology, will now be presented. From the author's viewpoint, Project Hindsight, with all of its limitations, produced very relevant findings for the science-technology conversion problem. A conceptual principle for accelerating the science-technology conversion can be abstracted from the Hindsight results, and it is important to separate the conceptual principle from the implementations of the principle. In this manner, one does not become bound by the limitations of any particular implementation. This principle, termed by the author as Heightened Dual Awareness (HDA), states that in order for the science-technology conversion to be accelerated, at least two necessary conditions must be fulfilled: 1) the researcher must be intimately aware of the needs of the applications engineer; 2) the potential user of the research, or transitionee, must be aware of the progress and results of the research. In addition, if third parties are involved in the conversion and development process, such as vendors, their awareness of both ends of the conversion cycle must be maintained as well. To the degree that each of these requirements is not fulfilled, the science-technology conversion will be retarded and delayed.

The author's personal observations of examples of science which has converted to technology rapidly have borne out the validity of the HDA principle, and of the above studies' conclusions related to evolution of research into successful systems. For example, the author sponsored research at the Department of Energy (DOE) National Labs for many years. In those cases where the departments in which the research was conducted were full spectrum S&T organizations, the researchers were often the developers as well, and in any case were well aware of the needs of the developers and users. The main motivations and incentives were to transition the research as rapidly as possible, and this in fact is what occurred. As a specific example, the Materials Department at Oak Ridge National Lab was a full spectrum materials R&D operation. Intermetallics research sponsored by the author for space applications metamorphisized into the high impact Ni3Al alloy research and development for terrestrial applications. The complete cycle from research to advanced development was conducted and completed very rapidly due to the vertically integrated materials structure at Oak Ridge.

The Oak Ridge example illustrates the most straightforward application of the HDA principle. The researchers and developers are physically contiguous, and in many cases are the same person. Thus, the dual awareness is readily effected by the intrinsic structure of the physical environment, and complex management structures are not necessary to enhance dual awareness.

When the author worked at Bell Laboratories in the 1960s and 70s, the research functions were linked closely with the advanced development functions through two major approaches. First, the more applied satellite laboratories were usually located adjacent to a Western Electric development and manufacturing facility, in a quasi-vertically integrated management structure (Bell Labs was an independent corporation). As in the Hindsight case, the researchers were well aware of the developers' and users' needs, and the potential users were kept apprised of the status of the research. This allowed simultaneous technology push and demand pull, and transitions occurred smoothly and rapidly.

Second, in the more centralized facilities in which the fundamental research was conducted, such as the Murray Hill laboratory, academic freedom characteristic of universities was combined with facility and staff support characteristic of the best industrial labs, with easy access to the developers. Not only did these centralized facilities contain contiguous applied research and development components, but the technical managers tended to be career Bell System employees who were extremely knowledgeable about the technological and operational needs of many different segments of the Bell System. Management awareness of both the research status and potential and technology and system needs helped strengthen the necessary linkages between basic research and the developers. A recent article [Heppenheimer, 1996] on the development of the transistor by Bell Labs illustrates this point. Following the invention of the point-contact transistor, the research director did not tell the inventor to redirect his work

toward further developing and refining the product. Instead, he gave that effort to another manager, and left the inventor free to seek newer frontiers.

In the Department of the Navy, much of the research at the Warfare Centers (full spectrum R&D organizations) is sponsored through the program managed by the author, the In-House Laboratory Independent Research program. Here, the Technical Directors of the Warfare Centers select projects focused on the Centers' mission requirements. The researchers tend to work part-time in development activities, and are continuously aware of both naval Fleet requirements and the state-of-the-art in the research community. Similar to the Oak Ridge example presented previously, when the researchers operate in such an applications-aware environment, their new ideas and concepts tend to be naturally associated with the naval applications, and have a higher probability of eventual utility. Fleet and technology impacts from this program have been substantial [ONR, 1996].

The HDA principle as a major driver of eventual utility is not limited to the performer and potential user; it is applicable to the research sponsor environment as well. A number of research sponsoring organizations have switched from a discipline orientation to a structure where the research is vertically integrated with technology, analogous to the vertically integrated research-technology performer environment described above.

For example, in 1993, the Office of Naval Research (ONR), a science and technology development sponsor, switched to such a structure in part for the purpose of closing the gap between science and technology, and initial indications are that this is indeed occurring. ONR's program officers (POs) are responsible for the range spanning research to advanced development, and, as in the integrated laboratory environment, are intimately aware of the needs of the users. The POs have the incentives to transition the research to development as rapidly as possible.

The general conclusion that the author has drawn is that for most effective and efficient conversion of science to technology, the researcher primarily and the sponsor secondarily need to be immersed in environments where the HDA principle is most operative, and where motivations and incentives are geared toward rapid transitioning. This type of physical environment is realized most efficiently when the researchers and developers are physically contiguous. If this type of physical environment structure is not readily possible, as may be the case with some extremely fundamental university research, then attempts should be made to simulate this optimal transitioning environment through innovative management structures. This should not be interpreted as a recommendation to substitute applied research for basic research. Far too much of this substitution has occurred in the recent past. Rather, the recommendation is that basic research be conducted in an environment where there is greater awareness of the progress and potential of the research by potential transitionees and users, and opportunities to understand the needs of the developers are made available to the researchers.

The irony is that the optimal transitioning research performer environment, from a physical structure viewpoint, exists most strongly (on average) today in two types of organizations: large corporate R&D labs and large government or national labs. Yet non-government-financed basic research has essentially disappeared from the large non-medical corporate labs, and the large government and national labs are being downsized. This trend can only impact the conversion of mission-oriented research negatively.

For mission-oriented agencies, to enhance the simulation of optimal transitioning physical structures, joint university-federal or national or corporate laboratory projects should be expanded. In parallel, as the author's personal observations have also shown, the potential user needs to become involved in the research project as early, broadly, and intensely as possible. This early involvement provides the user a sense of 'ownership', and produces a more seamless transition process. In the author's experience, incorporating the potential user from the research proposal evaluation phase is not too soon for successful downstream transitions of the research products to technology.

In summary, while the published retrospective studies do provide interesting information and insight into the transition process from research to development to products, processes, or systems, the **arbitrary selectivity and anecdotal nature of many of the results render any conclusions as to cost-effectiveness or generalizability suspect.** Supplementary analyses using other approaches are required for further justification of the value of the R&D.

IV-C. QUANTITATIVE METHODS

BACKGROUND AND OVERVIEW

As the U.S. national debt and annual deficit have increased in recent years, the government has been forced to focus its research more on strategic goals, in order to justify continuance of research funding in light of other urgent national priorities. There is increased competition for scarce funds in the Federal arena. Basic research, with its long-term payoff horizon, now has to compete strongly with medicare, welfare, and other service provision and development programs. In Europe and Asia, basic research has undergone a similar transformation, with more of a strategic focus to the research. Since the government throughout the world is now essentially the only supporter of basic research, eventually the draining of the fundamental knowledge pool will begin to affect the more applied work which draws upon the pool. The U.S. has not experienced these latent effects of fundamental research deficiency in a major way yet, because of the rich legacy of industrial and government support both at home and abroad and the continuing production of basic research from different government sources.

In this environment of scarce government funds, accountability of all government programs has increased substantially. There are

two major characteristics of recent focus in increased accountability: more detailed programmatic information is requested by the program assessors, and more quantified information is requested. The upsurge in computer availability over the past decade has enabled large quantities of detailed information to be stored, tracked, and interpreted, and has driven the request for the large volumes of detailed program information. The request for increased quantitative information also derives from the increased computer capabilities for handling and analyzing large amounts of this type of data. In addition, there is substantial motivation from the assessors to have simple quantitative indicators which could drive the resource allocation process, and substantiate and justify the resource allocation decisions that are generated.

For service, production, and some types of development programs, these quantitative indicators are applicable, meaningful, and useful in the assessment process. In the area of fundamental research, however, there is not uniform agreement on the validity of quantitative indicators for assessment purposes. Even among those who agree that quantitative indicators have a role in basic research assessment, there is not universal agreement as to which indicators are valid, and how and whether they should be combined with other quantitative indicators and non-quantitative approaches in order to arrive at a complete and meaningful system for research assessment.

This section addresses some critical issues in the applicability of quantitative performance measures to the assessment of basic research, which today is essentially synonomous with government sponsored basic research. The strengths and weaknesses of metrics applied as research performance measures are examined. In particular, the application of metrics in the context of the Government Performance and Results Act of 1993 is discussed and critiqued in section IV-C-1. The remainder of section IV-C provides an overview of the quantitative approaches used in research assessment.

Quantitative approaches to research assessment focus on the numerics associated with the performance and outcomes of research. The main approaches used are bibliometrics and econometrics such as cost-benefit and production function analysis. This section focuses on these three main approaches, then describes the bibliometrics-related family of approaches known as co-occurrence phenomena, then describes a network modeling approach to quantifying research impacts, and ends with an expert systems approach for supporting research assessment.

BIBLIOMETRICS

Bibliometrics, especially evaluative bibliometrics, uses counts of publications, patents, citations and other potentially informative items to develop science and technology performance indicators. The choice of important bibliometric indicators to use for research performance measurement may not be straightforward. A recent study surveyed about 4,000 researchers to identify

appropriate bibliometric indicators for their particular disciplines [Australia, 1993]. The respondents were grouped in major discipline categories across a broad spectrum of research areas. While the major discipline categories agreed on the importance of publications in refereed journals as a performance indicator, there was not agreement about the relative values of the remaining 19 indicators provided to the respondents. For the respondents in total, the important performance indicators were:

1. Publications (publication of research results in refereed journals);
2. Peer Reviewed Books (research results published as commercial books reviewed by peers);
3. Keynote Addresses (invitations to deliver keynote addresses, or present refereed papers and other refereed presentations at major conferences related to one's profession);
4. Conference Proceedings (publication of research results in refereed conference proceedings);
5. Citation Impact (publication of research results in journals weighted by citation impact);
6. Chapters in Books (research results published as chapters in commercial books reviewed by peers);
7. Competitive Grants (ability to attract competitive, peer reviewed grants from the ARC, NH&MRC, rural R&D corporations and similar government agencies).

These bibliometric indicators can be used as part of an analytical process to measure scientific and technological accomplishment. Because of the volume of documented scientific and technological accomplishments being produced (5,000 scientific papers published in refereed scientific journals every working day worldwide; 1,000 new patent documents issued every working day worldwide), use of computerized analyses incorporating quantitative indicators is necessary to understand the implications of this technical output [Narin, 1994].

Narin states three axioms that underly the utilization and validity of bibliometric analysis. The first axiom is activity measurement: that counts of patents and papers provide valid indicators of R&D activity in the subject areas of those patents or papers, and at the institution from which they originate. The second axiom is impact measurement: that the number of times those patents or papers are cited in subsequent patents or papers provides valid indicators of the impact or importance of the cited patents and papers. However, there could be weightings applied to the raw count data, depending on the perceived importance of the journals containing the citing papers. Also, the impacts would be on allied research fields or technologies, not necessarily long-term impacts on the originating organization's mission. The third axiom is linkage measurement: that the citations from papers to papers, from patents to patents and from patents to papers provide indicators of intellectual linkages between the organizations which are producing the patents and papers, and knowledge linkage between

their subject areas [Narin, 1994].

Use of bibliometrics can be categorized into four levels of aggregation [Narin, 1994]:

1. policy (evaluation of national or regional technical performance);
2. strategy (evaluation of the scientific performance of universities or the technological performance of companies);
3. tactics (tracing and tracking R&D activity in specific scientific and technological areas or problems);
4. conventional (identifying specific activities and specific people engaged in research and development).

Policy questions deal with the analysis of very large numbers of papers and patents, often hundreds of thousands at a time, to characterize the scientific and technological output of nations and regions. Strategic analyses tend to deal with thousands to tens of thousands of papers or patents at a time, numbers that characterize the publication or patent output of universities and companies. Tactical analyses tend to deal with hundreds to thousands of papers or patents, and deal typically with activity within a specific subject area. Finally, conventional information retrieval tends to deal with identifying individual papers, patents, and clusters of interest to an individual scientist or engineer or research manager working on a specific research project [Narin, 1994].

The first, and major, step in the performance of a high quality bibliometric analysis in any of the above four levels of aggregation is acceptance by the potential user of the above three axioms to validate the credibility of the bibliometric approach. Once this hurdle has been passed, the second step is to select the highest quality and reliability raw indicator products (data and databases) and apply analyses of the highest statistical precision and accuracy to these indicators [Braun, 1989, 1990, 1993]. The third step, which in many cases will determine the utility of the results, is the interpretation and visual display of the results. The results of the most stringent analyses will be relatively worthless if they are not displayed in a concise and lucid form.

Indicators can be arranged in one or more dimensions. Emphasis has always been laid on the necessity of multidimensional thinking while analyzing scientometric indicators. Scientific research is a multifaceted human activity, and overemphasizing any of its aspects (publication productivity, citation influence, technological applicability, etc.) may lead to serious distortions in its assessment. While each scientometric indicator represents a single component of a multidimensional manifold which itself is just one element in assessing a complex system, presentations in one or several dimensions may equally prove useful [Braun, 1993].

The most direct way of presenting scientometric indicators is in one dimensional ranked lists. While simplistic, this approach reflects the paramount competitiveness of the scientific enterprise. Linear rankings are most attractive for presentation to the larger non-specialist audience (see Braun [1993]).

Two dimensional displays can include relational charts or scatter plots for correlations. In two dimensional relational charts [Schubert, 1986; Braun, 1987], pairs of indicators (observed vs. expected citation rates or attractivity vs. activity indices)are displayed in a planar orthogonal coordinate system. Emphasis is shifted from ranking to the formation of groups or 'clusters' and other characteristic relations among various indicators.

An obvious deficiency of the relational charts is the lack of any indication of the size of the sets of publications underlying the points of the diagram. By adding the third dimension of publication size, this objection can be overcome. The basic idea of 'landscaping' national scientific performances is to represent the size by the 'mass' of a mountain-like formation. If two or more countries have similar citation characteristics, the peaks representing them may get superimposed forming chains, massifs, and other surface formations. An example is presented in Braun [1991].

There seems to be a natural limit of graphical presentation at three dimensions. There are techniques, however, to overcome this apparent restriction. A rather original method of representing multivariate data was proposed by Herman Chernoff: "Each point in k-dimensional space, k<=18, is represented by a cartoon face whose features, such as length of nose and curvature of mouth correspond components of the point. Thus every multivariate observation is visualized as a computer drawn face. This presentation makes it easy for the human mind to grasp many of the essential regularities and irregularities present in the data."

Braun [1993] shows a face pattern with 18 facial features applicable in representing multidimensional data. Schubert [1992] contains a four-dimensional example of applying Chernoff-faces in scientometrics: uncitedness, citation rate per cited paper, mean expected citation rate and relative citation rate are represented by the shape of face, size of eyes, length of nose and curvature and length of mouth, respectively.

Problems with Bibliometrics

Generating the bibliometric raw data and performing computer manipulations on this data are relatively straightforward processes. Interpreting and assigning meaning to this data lies at the source of the difficulties with bibliometrics. A personal anecdote partially illustrates this point.

A few years ago, the author was asked to be part of a team which reviewed a component of a large agency laboratory. Identification of the agency and laboratory is not important for this discussion. The team judged the work of the component to be excellent, but the number of papers produced relative to the component's funding was extremely small. Since the agency was trying to improve publication output of its laboratories, the team recommended that the component try to increase its publications.

A couple of years later, the team revisited the laboratory component. This time, the publication record was much improved. However, had the quality of research improved? No, the quality was

excellent in the first review and remained excellent in the second review. Had the quantity of research increased? No; in fact, one could probably make the argument that there was less research produced, since research time had to be sacrificed in writing the extra papers. Were the users more satisfied? No, since in either case the direct users were getting the quantity and quality research product they wanted, and were converting it to technology.

There appeared to be three main benefits of emphasis on publication. First, there was increased dissemination of the laboratory's results to the larger research community, which theoretically could have been of value to the community not familiar with the laboratory's work. The agency improved its bibliometric statistics, which it could then display as an example of increasing research productivity. In addition, there was probably some enhancement of the laboratory's and researchers' prestige due to the increased recognition in the published literature.

The main point to be derived from the above anecdote is that the fundamental bibliometric unit, the published paper in a peer reviewed journal, is not research; it is a documentation of research. While its contents are important in disseminating the research results and evaluating the quality and quantity of research produced, the documentation counts need to be associated with many more caveats and to be supported by much interpretation before they can become useful in a research evaluation.

A comprehensive review of bibliometrics [White, 1989] shows the sparsity of bibliometric studies for research impact evaluation reported by the Federal government. The reason for this is due in part to the following problems with publication and citation counts [King, 1987; Oberski, 1988; OTA, 1986]:

1) Publication counts:

a. indicates quantity of output, not quality;
b. non-journal methods of communication ignored;
c. publication practices vary across fields, journals, employing institutions;
d. choice of a suitable, inclusive database is problematical;
e. undesirable publishing practices (artificially inflated numbers of co-authors, artificially shorter papers) increasing.

2) Citations:

a. intellectual link between citing source and reference article may not always exist;
b. incorrect work may be highly cited;
c. methodological papers among most highly cited;
d. self-citation may artificially inflate citation rates;
e. citations lost in automated searches due to spelling differences and inconsistencies;
f. Science Citation Index (SCI) changes over time;
g. SCI biased in favor of English language journals;
h. same problems as publication counts.

In response to Cawkell's [1977] claims that 'citation anomalies have little effect-they are like random noise in the presence of strong repetitive signals,' MacRoberts [1989] stated the Federal concerns about bibliometrics eloquently: "When only a fraction of influences are cited, when what is cited is a biased sample of what is used, when influences from the informal level of scientific communication are excluded, when citations are not all the same type, and so on, the 'signal' may be repetitive, but it is also weak, distorted, fragmented, incoherent, filtered, and noisy".

Another reason for limited Federal use can be inferred from Narin [1976], where studies on the publication and citation distribution functions for individuals are reviewed. The conclusion drawn, from studies such as those of Lotka, Shockley, De Solla Price, and Cole and Cole, is that **very few of the active researchers are producing the heavily cited papers.** How motivated are funding agencies to report these hyperbolic productivity distributions for different programs in the open literature, especially since many questions exist as to the accuracy and completeness of the bibliometric indicators? This conclusion raises the further question of the role actually played by the less productive researchers (as measured by publication and citation counts): is the productivity of the elite somehow dependent on the output of the less influential, or is the role of the less productive members that of maintaining the stability of the research infrastructure and educating future generations of researchers?

Potential Normalization Approaches

Another problem with bibliometrics is cross-discipline comparisons of outputs. For example, how should the paper or citation output of a program in Solid-State Physics be compared to that of Shallow Water Acoustics. What types of normalizations are required to allow comparisons among these different types of programs and fields. Is there a threshold for disaggregation below which the normalization factors apply to all the subfields. For example, can the normalization factor for Acoustics be applied to a program in High Frequency Shallow Water Acoustics, or can the normalization factor for Shallow Water Acoustics be applied to the program in High Frequency Shallow Water Acoustics?

While many researchers and organizations have been concerned about this issue, a group centered at the Library of the Hungarian Academy of Sciences has been addressing the problem of output comparisons, including cross-discipline comparisons, in detail for many years. The following normalization solutions they propose are excerpted from a recent publication [Schubert, 1993]. In addition, the author has recently generated a new approach for comparing citation rates across different disciplines [Kostoff, 1997m], and excerpts are contained in Section IV-C-2.

1. **The Publishing Journal as Reference Standard**

Primary journals in science are generally agreed to contain coherent sets of papers both in contents and in professional

standards. This coherence stems from the fact that most journals are nowadays specialized in quite narrow subdisciplines and the "gatekeepers" (i.e., the editors and referees) controlling the journal are members of an "invisible college" sharing their views on questions like relevance, validity or quality.

It seems, therefore, justified to expect the same level of citation rate for papers published in the same journal at the same time. If two such papers receive a different number of citations, one may rightly suspect that this reflects differences in their inherent qualities. By relating the number of citations received by a paper (or the average citation rate of a subset of papers published in the same journal - the **Mean Observed Citation Rate, MOCR**) to the average citation rate of all papers in the journal (the **Mean Expected Citation Rate, MECR**) the **Relative Citation Rate (RCR)** will be obtained. This indicator shows the relative standing of the paper (or set of papers) in question among its close companions: it value is higher\lower than unity as the sample is more\less cited than the average. In general, sets of papers under investigation are published in more than one journal; in that case, the mean expected citation rate (MECR) can be defined as the average citation rate of the journals. (The weights are, of course, the publication frequencies in the respective journals.) The mean observed citation rate (**MOCR**), i.e., the average citation rate per paper can again be related to the **MECR** to result in the relative citation rate (**RCR**), indicating the relative impact of the papers in question among the average papers of the publishing journals as reference standard.

There are some weaknesses inherent in using the publishing journal as reference standard. Papers published in multidisciplinary journals are measured by common standards, which might be clearly unfair, say, for a geoscience article published in Nature together with a molecular genetics paper. Since journals form a virtually continuous spectrum from highly specialized to multidisciplinary, and different research fields or even subcommunities in the same field may typically use different segments of this spectrum, the unbiasedness of the reference standards must be thoroughly checked whenever comparative assessments are based on the **RCR** indicator.

As a rule, it can be said that in coherent research fields, where papers are usually published in specialized journals (as is the general trend in contemporary science) published journals as reference standards and **RCR** as indicator can readily be proposed for comparative assessments. It must, however, be added that even in such cases extension from one to two dimensions may multiply the effectiveness of the analysis.

2. The Set of Related Records as Reference Standard

"Bibliographic Coupling" uses the number of references a given pair of documents have in common to measure the similarity of their subject matter. Comparing a set of papers that are "similar" in this sense to a given article of the same age will yield an ideal reference standard for citation assessments. This apparently

simple and straightforward method has long been practically un accomplishable because of the technical difficulties of collecting the "coupled" papers, by using any traditional version of citation indexes.

Fortunately, the situation has radically changed with the advent of the **CD-ROM edition** of the **Science Citation Index** database. The **SCI CD Edition** uses bibliographic coupling under the name **related records.** Two records are considered "related" when they list a number of identical papers in their respective bibliographies. Related records of an article are other articles published during the same period that cite at least one of the same references that the "parent" article cited. Because they have references in common, an article and its related records are supposed to be also related by subject. In general, the more references in common, the stronger the subject similarity between two articles. The **SCI CD Edition** has a built-in possibility for searching related records: a maximum of 20 related records are available for any given record ranked by strength of relatedness.

In an exploratory study of using **SCI CD Edition** for comparative evaluation of citation impact, the publication output of the Hungarian pharmaceutical company CHINOIN in 1986 was investigated. Three conclusions from the Study are:

a. Both for CHINOIN publications and for the "related records", observed citation rates per paper fall short of expected values. Thus it seems that the research topics of CHINOIN are not the "hottest spots" of their respective subject field, which does not, however, qualify the research in any means.

b. Although the expected citation rate of CHINOIN publications is rather close to that of the standard reference set ("related records"), their actual citation rate falls fare below. Earlier studies concerning longer time periods did not show such a gap between expected and observed citation rates. The relatively low rate of subsequent year citations can most probably be attributed to insufficient informal, prepublication communication of research.

c. The observed citation rate of the related records is conspicuously close to the expected citation rate of the "parent" CHINOIN publications. This finding, in a sense, validates the use of relative scientometric indicators based on the comparison of actual with expected (journal average) citation rates. At least in the case of the present sample, the much more sophisticated "customized" control group-compiled on the principle of bibliometric coupling-obtains the same citation level as reference standard as did the simple journal average.

In subject fields less coherent than pharmaceutical research, however the differences might be much more substantial, and the use of the set of related records as a more reliable reference standard is certainly worth the additional effort.

3. The Set of Cited Journals as Reference Standard

The set of publications to be assessed may represent various levels of aggregation, such as research teams, institutions, or whole research communities of a given subfield in a given country. Independently of the level of investigation, the publishing journal is a useful and reliable reference standard for citation assessments - bearing in mind the caveats earlier mentioned. In one particular case, however, this approach fails completely, namely, if journals themselves are subjected to comparative assessment. There is an ever growing interest in evaluation of journals by citation analysis and one of the crucial questions, in this case too, is the comparison of journals publishing in science subfields of inherently different citation levels.

One possible solution might be again the use of related records. It is however, practically impossible to retrieve the related records to every single article of just one volume of a medium size journal and to collect their citations.

Standardization of citation levels by subfields and comparing the standardized scores has been attempted. This approach was found to be loaded with the inherent arbitrariness in the categorization of the journals into subfields and the ambiguity of treating inter- or multidisciplinary journals.

A method which now seems to provide the most satisfactory resolution at the lowest cost in terms of computer and\or manual search is based on the **journal in the reference lists of the articles of the journal in question.** These journals were selected by the most reliable persons, the authors of the journal as references (in both senses of the word) and therefore, can justly be regarded as standards of the expected citation rate.

All but a very few journals fall far below the standard set by their references. This is perhaps because authors tend to base their statements on the most authoritative sources. In every research area, a hierarchy of journals is set-up with one or just a few journals on the top and all others tend to cite "upwards".

A detailed study has been made on 2459 journals covered continuously be **SCI** in the period 1981-1985, and publishing at least 50 papers in these five years. Only 140 of them proved to be cited above the average of their cited references. This subset may rightly be considered the "chosen few" of the community of journals.

A closer look at this subset reveals that a considerable number of these journals are **review journals**, some of them having the work "review" even in their title. This is not too surprising, since review papers are well known to be cited much above the average. It is, however, interesting to realize that analysis of cited journals provides a simple means to distinguish review journals from "ordinary" ones. The indicator is the fraction of journal self-citations in all citations. Evidently, this fraction is much lower for review journals (collecting, by their very nature, references from a much wider pool of journals) than for primary journals.

Bibliometric Validation

In a comprehensive survey of problems with citation analysis, MacRoberts and MacRoberts [1996] list many deficiencies with citation analysis. In particular, they read papers in technical fields with which they were familiar, and compared the influence evident in the text with what was contained in the bibliography. They found that approximately 30% of the influence was cited. Their paper is one of the few cases where this type of validation study has been performed.

The Pied Piper Effect

One of the main concerns with using citations as a stand-alone measure of quality and impact has been the potential bimodal interpretation of the numerical results. A paper could receive high citations because of its high quality, or because the citers disagree with it. However, there is a third interpretation which further precludes citations being utilized in stand-alone mode, which the author has termed the "Pied Piper" effect.

Assume there is a present-day mainstream approach in a specific field of research; for example, the chemical/ radiation/ surgical approach to treating cancer (See section IV-C-3 for a more detailed example of the "Pied Piper Effect"). Assume that in, say, fifty years a cure for cancer is discovered, and the curative approach has nothing to do with today's research. In fact, assume it turns out that today's approach was completely orthogonal or even antithetical to the correct approach. Then what meaning can be ascribed to research papers in cancer today which are highly cited for supposedly positive reasons?

In this case, a paper's citations are a measure of the extent to which the paper's author has persuaded the research community that the research direction contained in his paper is the correct one, and not a measure of the intrinsic correctness of the research direction. In fact, the citations may reflect the desire of a closed research community (the author and the citers) to persuade a larger community (which could include politicians and other resource allocators) that the research direction is the correct one. This is the "Pied Piper" effect. The large number of citations in the above hypothetical medical example becomes a measure of the extent of the problem, the extent of the diversion from the correct path, not the extent of progress toward the solution. The "Pied Piper" effect is a key reason why, especially in the case of revolutionary research, citations and other quantitative measures must be part of and subordinate to a broadly constituted peer review in any credible evaluation and assessment of research impact and quality.

Examples of Bibliometric Studies

Macroscale bibliometric studies characterize science activity at the national [e.g., Hicks, 1986; Braun, 1989], international, and discipline level. The biennial Science and Engineering Indicators report [NSF, 1996] tabulates data on characteristics of personnel in science, funds spent, publications and citations by

country and field, and many other bibliometric indicators. Another study at the national level was aimed at evaluating the comparative international standing of British science [Martin, 1990]. Using publication counts and citation counts, the authors evaluated scientific output of different countries by technical discipline as a function of time.

There is little evidence that the results from such studies have much influence on policy or decision-making; i.e., the allocation of resources. As Martin et al point out in their conclusions, there is potential benefit for a country to understand its position vis-a-vis that of its competitors in different science areas, in order to be able to exploit opportunities which may arise in those areas. However, which indicators are appropriate and how they should impact allocation decisions are open questions.

There have been numerous microscale bibliometric studies reported in the literature [e.g., Frame, 1983; McAllister, 1983; Mullins, 1987, 1988; Moed, 1988; Irvine, 1989; Van Raan, 1989; Luukkonen, 1990a, 1990b, 1992]. With the notable exception of the NIH [OTA, 1986], few Federal agencies report use of microscale bibliometric studies to evaluate programs and influence research planning in the published literature. The NIH bibliometric-based evaluations included the effectiveness of various research support mechanisms and training programs, the publication performance of the different institutes, the responsiveness of the research programs to their congressional mandate, and the comparative productivity of NIH-sponsored research and similar international programs.

Two recent papers [Narin, 1987b, 1989] described determination of whether significant relationships existed among major cancer research events, funding mechanisms, and performer locations; compared the quality of research supported by large grants and small grants from the National Institute of Dental Research; evaluated patterns of publication of the NIH intramural programs as a measure of the research performance of NIH; and evaluated quality of research as a function of size of the extramural funding institution. Most of the NIH studies focused on aggregated comparison studies (large grants vs small, large schools vs small schools, domestic vs foreign, etc).

Patent citation analysis has the potential to provide insight to the conversion of science to technology [Carpenter, 1981, 1982, 1983; Narin, 1984; Wallmark, 1986; Collins, 1988; Narin, 1988a, 1988b, 1988c; Van Vianen, 1990; Narin, 1991, 1992]. Much of the Federal government support of the development of patent citation analysis was by the NSF [e.g., Carpenter, 1980; Narin, 1987a], although **there is little published evidence now of widespread Federal use of this capability.** Some recent studies have focused on utilization of patent citation analysis for corporate intelligence and planning purposes (Narin, 1990, 1992a, 1992b). Some of the data presented verify further Lotka's Productivity Law, where relatively few people in a laboratory are producing large numbers of patents. In the example presented in Narin [1992b], the patents of the most productive inventor are highly cited, further

demonstrating his key importance. Narin concludes that highly productive research labs are built around a small number of highly productive, key individuals.

An ongoing study of citations to scientific papers from the front pages of U.S. patents has potentially important implications for science and technology policy. Some results showed that, for different countries that file patents with the U.S. patent system, each country's patents in the U.S. cite their own scientific papers three times as often as would be expected, after normalizing out the size of each country's science [Narin, 1994]. To end this discussion of patent citation analysis on a cautionary note, courtesy of Pavitt [1991], it is not yet clear to what extent the 'other publications', cited in patents, reproduce basic or applied research, from universities or corporate laboratories. In addition, a high proportion [Pavitt's estimation] of technology is not patented, because it is kept secret, because it is tacit and non-codifiable art, or because - as in the case of software technology - it is very difficult to protect through patents.

Despite these limitations, bibliometrics may have utility in providing insight into research product dissemination. For example, in a recent series of presentations to large Federally-funded laboratories [Kostoff, 1992b], the following suite of bibliometric studies was proposed:

1. Examine distribution of disciplines in co-authored papers, to see whether the multidisciplinary strengths of the lab are being utilized fully;
2. Examine distribution of organizations in co-authored papers, to determine the extent of lab collaboration with universities/ industry/ other labs and countries;
3. Examine nature (basic/ applied) of citing journals and other media (patents), to ascertain whether lab's products are reaching the intended customer(s);
4. Determine whether the lab has its share of high impact (heavily cited) papers and patents, viewed by some analysts as a requirement for technical leadership;
5. Determine which countries are citing the lab's papers and patents, to see whether there is foreign exploitation of technology and in which disciplines;
6. Identify papers and patents cited by the lab's papers and patents, to ascertain degree of lab's exploitation of foreign and other domestic technology.

While it was also recommended that the lab compare its output (papers/ citations normalized over disciplines) with that of other similar institutions, this quantitative comparison should be approached with great caution. A recent comparative bibliometric analysis of 53 laboratories [Miller, 1992] clustered the labs into six types (Regulation and Control, Project Management, Science Frontier, Service, Devices, Survey), and stated that "comparisons of scientific impacts should be made only with laboratories that are comparable in their primary task and research outputs". The

report concluded further that:

1. Bibliometric indicators and scientific publications are not the only outputs that should be measured, but the other types of outputs differ for different labs;

2. Bibliometric indicators are not equally valid across different types of laboratories;

3. Bibliometric indicators are less useful for the evaluation of research laboratories involved in closed publication markets.

In addition, studies were performed [Kostoff, 1992c] to track the dissemination of information from accelerated research programs. Key papers (P1) resulting from these programs were identified, then the citing papers for these key papers (P2) were identified, then the next generation of citing papers (P3) which cited P2 were identified, and so on. The breadth of disciplines impacted by the key papers (P1) can be identified from the succeeding generations of citing papers. The type of analysis done so far provided more of a qualitative than quantitative estimation of breadth of impact.

Preliminary results show that some very fundamental papers impact across a wide spectrum of disciplines, while some high quality but more narrowly focused research papers impact one main discipline very strongly through succeeding generations of citations. Because of the large amounts of data required for a complete analysis, especially where highly cited papers and their descendents are concerned, present efforts focus on methods to reduce data requirements and retain a credible analysis.

COST-BENEFIT/ ECONOMIC ANALYSES

<u>Background</u>

A comprehensive survey examined the application of economic measures to the return on research and development as an investment in individual industries and at the national level [OTA, 1986]. This document concluded that while econometric methods have been useful for tracking private R&D investment within industries, the methods failed to produce consistent and useful results when applied to Federal R&D support.

An intermediate study published by the Commission of the European Communities [Capron, 1992] concluded that "the economic quantitative methods, particularly econometric models, should be viewed as an ex post quantitative evaluation tool of the economic impacts of science and technology policy. They have their shortcomings and limits. They are an instrument in the toolbox of policy evaluation which can be used for structured quantitative analyses of the economic impact of R&D policy......The economic impact of government financed R&D might be evaluated by using simultaneously existing pinpoint methods and extended macroeconometric models. While existing pinpoint methods are numerous, the most commonly used ones are the productivity and the investment approaches. Extended macroeconometric models might be

conceived by adapting present macromodels or developing adequate models."

A more recent analysis focused on economic/ cost-benefit approaches used for research evaluation [Averch, 1994]. The methods involve computing impacts using market information, monetizing the impacts, then comparing the value of the impacts with the cost of research. Principal measures described include surplus measures and productivity measures. With known benefit and cost time streams, internal rates of return to R&D investments are then computed. The paper notes both the standard technical difficulties with these approaches and the political and organizational difficulties in implementing them.

Classical Microlevel Application

Cost-benefit analysis has limited accuracy when applied to basic research because **of the quality of both the cost and benefit data due to the large uncertainties characteristic of the research process, as well as selection of a credible origin of time for the discounting computations.** As an illustrative example, a cost-benefit analysis performed on a fusion reactor variant (the fusion-fission hybrid, essentially a fission reactor driven by fusion neutrons which can produce both fissile fuel and power) will be described in some detail.

Rutherford's experiments in 1934 involving interaction of a deuteron beam with solid deuterium can be viewed as the genesis of fusion fuel cycle research [Kostoff, 1983a]. Almost since the formation of the AEC in the mid-1940s, the Federal government has invested significant sums of money for the potential promise of controlled fusion as an essentially limitless source of energy. In 1979, an economic analysis based on capital costs was performed on the fusion hybrid and a comparison was made with two major contenders for the same type of product, fast breeders and accelerator breeders [Kostoff, 1979]. The results showed projected cost savings (for different parameter variations) for developed fusion hybrid systems but did not address the time distribution or magnitude of development costs. Subsequent technical studies showed ranges of favorable operating conditions based on fusion reactor cycling times [Kostoff, 1981, 1982a, 1982b, 1983b, 1985].

To evaluate the economic potential of the fusion-fission hybrid, an incremental cost-benefit analysis was performed [Kostoff, 1983a]. While fusion-related expenditures could be traced back to Rutherford's experiments in 1934, this study ignored fusion hybrid research expenditures before 1980 (sunk costs from the perspective of 1980). For the parameter ranges chosen, it was shown that there was a broad region over which hybrid development could prove cost-effective. However, **had this same analysis been done in 1934 (around the beginning of identifiable basic research for fusion), using the same cost and benefit streams as in the 1983 study plus adding costs incurred between 1934 and 1980 and discounting back to 1934, then the result would have been much different from the 1983 study.**

In the 1983 study, the problem was treated deterministically;

uncertainties or probabilities of success of the different parameter values being achieved were not taken into account. **The real problem, which pervades and limits any attempt to perform a cost-benefit analysis on a concept in the basic research stage, was the inherent uncertainty of controlling the fusion process. This translated to the inability to predict the probabilities of success and time and cost schedules for overcoming fundamental plasma research problems (e.g., plasma stabilities and confinement times); no credible methods were available**. Thus, the main value of the cost-benefit approach was to show that the potential existed for positive payoff from the hybrid reactor development, that there was a credible region in parameter space in which controlled fusion development could prove cost effective; **what was missing was the likelihood of achieving that payoff.**

Macrolevel Analyses

Much of the major recent economic work relating economic growth/ productivity increases to R&D spending has been performed by three economists [Mansfield, 1980, 1991; Terleckyj, 1977, 1985; Griliches, 1979]. Probably the most widely publicized work over the past decade to examine rates of return from basic research has been that of Mansfield [e.g., Mansfield, 1980, 1991]. His results indicated that substantial social rates of return can be attributed to basic research. While use of his methods by government officials has not been reported in the literature, the methods have received widespread attention among research policy-makers. Because of the potential impact of these methods if adopted, both his production function and recent marginal cost-benefit approaches will be discussed.

Production Function Approach

The earlier study [Mansfield, 1980] attempted to determine whether an industry's or firm's rate of productivity change was related to the amount of basic research it performed. Mansfield developed a production function which disaggregated basic and applied research, then regressed rate of productivity increase with many different variables. The regressions showed a strong relationship between the amount of basic research carried out by an industry and the industry's rate of productivity increase during 1948-1966.

However, many assumptions were necessary to solve the equations: constancy of ratios of variables over time; neglect in the actual regression equations solved of the (long) lag time between when the research is performed and when the productivity change is measured (though this point is recognized and discussed by Mansfield); and the inherent uncertainties in the data used in the equations. The results have to be treated as highly uncertain. In fact, Mansfield's results are somewhat inconsistent with the findings of the second part of his study, which showed, for 119 major firms surveyed, that the proportion of R&D expenditures devoted to basic research and to relatively risky projects declined between 1967 and 1977 in most industries. **Would firms reduce their**

own basic research expenditures if they felt that their own basic research expenditures would result in increased productivity?

Finally, there is the problem inherent in multiple regression analyses: that of determining cause and effect from what is essentially correlation. As Mansfield points out, "It is possible that industries and firms with high rates of productivity growth tend to spend relatively large amounts on basic research, but that their high rates of productivity growth are not due to these expenditures" [Mansfield, 1980]. Nor does Mansfield's model specify the path(s) by which R&D investment supposedly leads to productivity improvements.

Recent Macrolevel Marginal Cost-Benefit Application

A recent study weighed the costs of academic research against the benefits realized from the earlier introduction of innovative products and processes due to the academic research [Mansfield, 1991]. A survey of corporate R&D executives showed that an average of seven years elapsed between a research finding and commercialization, and that commercialization would have been delayed an average of eight years without academic research. A cost-benefit analysis using this survey data showed a very high social rate of return resulting from academic research.

However, the data were not validated independently by a document-based type of analysis (such as TRACES or Hindsight, retrospective studies of innovations) of a sample number of the products and processes. The time between the research findings and commercialization is very short compared to the results of Hindsight or the TRACES studies, and is more in line with the lag time between the **end** of basic research and commercialization shown by Hindsight/TRACES. Use of a shorter lag time in the discounting process increases the benefit/cost ratio and the social rate of return. While the method is innovative, a more objective data source would provide higher confidence in the computed rates of return.

COST-EFFICIENCY

A recent production function approach to cost-efficiency of basic research essentially used a regression analysis between outputs and inputs [Averch, 1987, 1989]. In its latest incarnation, performed on NSF Chemistry proposals when Averch was at NSF, the method involved regressing output variables (citations per dollar, graduate students per dollar) against input variables (e.g., quality of the investigator's department, quality of the investigator, etc.). The results gave some idea of the importance of the input variables, alone or in combination, on the output variables. One obvious potential application would be prediction of proposals likely to have high productivity based on prior (input) knowledge. **Much, however, remains to be done in identifying the appropriate output measures, the appropriate input measures, and the nature of the interactions among these measures for different disciplines.**

CO-OCCURRENCE PHENOMENA

Background

Modern quantitative techniques utilize computer technology extensively, usually supplemented by network analytic approaches, and attempt to integrate disparate fields of research. One class of techniques which tends to focus more on macroscale impacts of research exploits the use of co-occurrence phenomena. In co-occurrence analysis, **phenomena that occur together frequently in some domain are assumed to be related, and the strength of that relationship is assumed to be related to the co-occurrence frequency.** Networks of these co-occurring phenomena are constructed, and then maps of evolving scientific fields are generated using the link-node values of the networks. Using these maps of science structure and evolution, the research policy analyst can develop a deeper understanding of the interrelationships among the different research fields and the impacts of external intervention, and can recommend new directions for more desirable research portfolios.

Little evidence of Federal use of these techniques (co-citation, co-word, co-nomination, and co-classification analysis) has been reported in the open literature. However, as computerized databases get larger, and more powerful computer software and hardware become readily available, their utilization in assessing research impact should increase substantially. These techniques are discussed in more detail in Kostoff [1992a- Appendix III, 1993c, 1994h]; Tijssen [1994]. The Tijssen paper contains an excellent exposition on mapping techniques for displaying the structure of related science and technology fields.

Overview Summary

Co-citation analysis has been applied to scientific fields, and co-citation clusters have been mapped to represent research-front specialties [Tijssen, 1994]. Co-word has been utilized to map the evolution of science under European (mainly French) government support, and has the potential to supplement other research impact evaluation approaches. Co-nomination, in its different incarnations, has been used to construct social networks of researchers and has the potential, if expanded to include research and technology impacts in the network link values, for evaluating direct and indirect impacts of research. Co-classification is based on co-occurrences of classification codes in patents, and is used to construct maps of technology clusters [Engelsman, 1991].

Co-citation Analysis

Three of the more applicable co-occurrence techniques to the science evolution problem, listed in order of level of development and frequency of utilization, are co-citation, co-word, and co-nomination. In co-citation analysis, the frequencies with which references in published documents are cited together are obtained, and are eventually used to generate maps of clusters of cohesive

research themes. Co-citation analysis was developed about two decades ago, when the Science Citation Index became more readily available for computer analysis, and it has spawned a number of studies and reviews, a few of which are listed here [Small, 1973, 1977, 1978; Garfield, 1978; Small, 1980, 1985a, 1985b, 1986; Franklin, 1988; Oberski, 1988; Braam, 1991a, 1991b].

It should be noted that co-citation is a rather indirect approach to obtaining connectivity among research areas, and it involves a number of abstract steps. Querying the author(s) of a research paper about what other research areas are related to their work would be the most direct method of obtaining the desired data [Kostoff, 1991c, 1992a-Appendix I, 1994i]. Obtaining this information by analyzing the words in the paper and related papers would be the next most direct method. Obtaining this information by examining citations and co-citations restricts the types of documents which can be analyzed (essentially published papers) and requires the additional assumption that the themes of two articles co-cited many times by authors must be strongly related. While the co-citation proponents claim that "many potentially useful applications have been demonstrated" [Franklin, 1988], others conclude that "results of co-citation cluster analyses cannot be taken seriously as evidence relevant to the formulation of research policy" [Oberski, 1988].

Co-nomination Analysis

Co-nomination is a particular example of the more general social network analysis used to study communication among workers in the fields of science and technology. Generally, in co-nomination, experts in a given field are asked to identify other experts, and then a network is generated which shows the different linkages (and the strengths of these linkages) among all the experts (and possibly their organizations and technical disciplines) identified. A recent survey [Shrum, 1988] of the development of social network analysis traces studies in this area back at least three decades. Two of these studies are particularly relevant to the specific co-nomination approach which will be described, and these two studies are outlined briefly.

In a study of theoretical high energy physicists [Libbey, 1967], respondents were asked to name two persons outside their institution with whom they exchanged research information most frequently and no more than three who they believed to be doing the most important work in their area. A network analysis was done to identify communication linkages. In a later study of theoretical high energy physicists [Blau, 1978], respondents were asked to name two persons outside their institution with whom they exchanged information most frequently about their research. Again, communication networks were generated.

Co-nomination was developed to circumvent co-citation's dependence upon databases consisting of refereed scientific publications. **It is a more direct approach of obtaining links among researchers and, if combined with other network approaches which include both links between technical fields and the link**

strengths [Kostoff, 1991c, 1992a-Appendix I, 1994h, next section in Handbook], could potentially incorporate links among researchers and technical fields. Since co-nomination is known less well than co-citation, its latest embodiment will be described briefly.

Researchers are sent a questionnaire inviting them to nominate other researchers whose work is most similar or relevant to their own. Based on the responses, networks are then constructed by assuming that links exist between co-nominated researchers and that the strength of each link is proportional to the frequency of co-nomination [Georghiou, 1988]. However, as is the case with co-citation, frequency of co-occurrence may not be a unique indicator of strength. One could postulate two cases: 1) researchers co-nominated were doing essentially identical work, and their linkages were very strong; and 2) researchers were doing vaguely similar work, and their linkages were very weak. In both cases, the frequency of co-occurrence would be the same, and the links on the network would have the same strength.

Co-word Analysis

The origins of co-word analysis in linguistics, lexicography, and especially computational linguistics can be found in Hornby [1942], De Saussure [1949], Firth [1957], Chomsky [1965], Halliday [1966], Harris [1968], Sparck Jones [1971], McKinnon [1977], Van Rijsbergen [1979], Melcuk [1981], Bahl [1983], Choueka [1983], Salton [1983], Sparck Jones [1984]; Benson [1986], Kittredge [1986], Choueka [1988], McCardell [1988], Nirenberg [1988], Smadja [1988], Amsler [1989], Church [1989], Maarek [1989], Salton [1989]; Smadja [1989], Church [1990], Iordanskaja [1990], Mays [1990], McDonald [1990], Smadja [1991]. These origins of co-word analysis are summarized in Kostoff [1991d, 1992a, 1993c, 1994h], along with a detailed description of modern day development and applications of co-word analysis to research policy and issues.

In summary, co-word has been utilized to map the evolution of science under European (mainly French and Dutch) government support [Callon, 1979, 1983; Rip, 1984; Bauin, 1986; Callon, 1986; Courtial, 1986; Healey, 1986; Leydesdorff, 1987a, 1987b; Bauin, 1988; Rip, 1988; Turner, 1988; Courtial, 1989; Leydesdorff, 1989; Whittaker, 1989; Courtial, 1990a, 1990b; Callon, 1991a; Braam, 1991a, 1991b; Callon, 1991b; Peters, 1991; Van Raan, 1991; Tijssen, 1994]. Until recently, the database used was essentially limited to journal papers. The frequency of co-occurrence of index or key words for these papers was the starting point for the maps which followed. Use of index words led to a biasing termed the 'indexer effect' [Healey, 1986] and effectively restricted the acceptability of co-word analysis for many years.

DATABASE TOMOGRAPHY

Recently, a new co-word approach that deals directly with text and requires no indexing or key words was developed [Kostoff, 1991b, 1991d, 1992a, 1993c, 1993e, 1993f, 1994h, 1993g, 1994k]. The methodology can be applied to any text database, consisting of

published papers, reports, memos, etc., which can be placed on computer storage media. This revolutionary approach has been used to identify pervasive thrust areas of science and technology, the connectivity among these areas, and sub-thrust areas closely related to and supportive of the pervasive thrust areas. The approach utilizes a computer-based algorithm to extract and order data from a large body of textual material which, for example, may describe a broad spectrum of science. The algorithm extracts words and word phrases which are repeated throughout this large database, and allows the user to create a taxonomy of pervasive research thrusts from this extracted data. The algorithm then extracts words and phrases which occur **physically close** to the pervasive research thrusts throughout the text, and allows the user to determine interconnectivity among the research thrusts, as well as determine research sub-thrusts strongly related to the pervasive thrusts. While the focus of applications has been to identify **technical** thrusts and their interrelationships, the raw data obtained by the extraction algorithms allows the user to relate **technical thrusts to institutions, journals, people, geographical locations, and other categories.** An application to a Former Soviet Union (FSU) text database follows. This text describes a broad spectrum of FSU science (35 reports generated by the Foreign Applied Sciences Assessment Center (FASAC)).

Background

About a decade ago, the U.S. Federal Government established the Foreign Applied Sciences Assessment Center (FASAC) under the operation of the Science Applications International Corporation (SAIC). The purpose of FASAC was to increase awareness of new foreign technologies with military, economic, or political importance. The emphasis was placed on "exploratory research" (Department of Defense 6.1/6.2 equivalent) in the FSU. This work seeks to translate fundamental research into new technology.

One of the main products of FASAC is reports on different areas of "exploratory research." FASAC assembles panels of expert consultants from academia, industry, and government. Each panel provides a written assessment of the status and potential impacts of foreign applied science in selected areas. Periodically, an Integration Report is generated that describes the trends in foreign research, including pervasive issues which affect research capabilities. By early 1992, there were about 40 reports on different aspects of FSU applied science.

Database Tomography utilizes the proximity of words and their frequency of co-occurrence in some domain (sentence, paragraph, paper) to estimate the strength of their relationship. When applied to the literature in a technical field, Database Tomography allows a map of the relationship among technical themes to be constructed. The initial purpose of the Database Tomography development was to identify pervasive research thrusts (thrusts which transcend disciplines) from those large text databases which contain descriptions of many research programs or areas of research. Two initial applications have been reported [Kostoff,

1997p]:

1. Identification of pervasive research thrusts in a database describing promising research opportunities for the Navy. The database consisted of thirty reports produced by the National Academy of Sciences panels and Office of Naval Research (ONR) internal experts on 15 technical disciplines.

2. Identification of pervasive thrusts in the 7400 project Industrial R&D (IR&D) database.

Applications to other large databases are ongoing, and they include the following:

1. Identification of pervasive themes and their relationships in a database of reports (FASAC) describing applied technical research topics in the Former Soviet Union (Kostoff, 1993e, 1993f)

2. Identification of pervasive themes in a database whose narrative components describe each research project sponsored by the Department of Energy

3. Identification of pervasive themes and their relationships in a database of journal articles related to Research Impact Assessment (Kostoff, 1995a, 1997d)

4. Identification of pervasive themes and their relationships in a database of journal articles consisting of one year's issues of the Journal of the American Chemical Society (Kostoff, 1997d)

5. Identification of pervasive themes and their relationships in a database of journal articles related to Near-Earth Space Science and Technology (Kostoff, 1997e)

The reported studies and the present study have used the following procedure:

First, the frequencies of appearance in the total text of all single words (for example, MATRIX), adjacent double words (METAL MATRIX), and adjacent triple words (METAL MATRIX COMPOSITES) are computed. The highest frequency technical content words are selected as the pervasive themes of the full database (for example, SHOCK WAVE, REMOTE SENSING, IMAGE PROCESSING).

Second, for each theme word, the frequencies of words within +-50 words of the theme word for every occurrence in the full text are computed. A word frequency dictionary is constructed which shows the words closely related to the theme word. Numerical indices are employed to quantify the strength of this relationship. Both quantitative and qualitative analyses of each dictionary (hereafter called cluster) yield those subthemes closely related to the main cluster theme.

Third, threshold values are assigned to the numerical indices. These indices are used to filter out the most closely related words to the cluster theme (e.g., see Figure 1 below for part of a typical filtered cluster from the FASAC study).

```
Cij...Ci......Ii.......Eij........CLUSTER.MEMBER
............(Cij/Ci)..(Cij^2/CiCj)

022...0036....0.611....0.0359.....THERMAL.INFRARED
056...0323....0.173....0.0259.....ICE
```

070...0522....0.134....0.0250.....SATELLITE

CODE:
Cij IS CO-OCCURRENCE FREQUENCY, OR NUMBER OF TIMES CLUSTER MEMBER APPEARS WITHIN +-50 WORDS OF CLUSTER THEME IN TOTAL TEXT;
Ci IS ABSOLUTE OCCURRENCE FREQUENCY OF CLUSTER MEMBER;
Cj IS ABSOLUTE OCCURRENCE FREQUENCY OF CLUSTER THEME;
Ii, THE CLUSTER MEMBER INCLUSION INDEX, IS RATIO OF Cij TO Ci; AND
Eij, THE EQUIVALENCE INDEX, IS PRODUCT OF INCLUSION INDEX BASED ON CLUSTER MEMBER Ii (Cij/Ci) AND INCLUSION INDEX BASED ON CLUSTER THEME Ij (Cij/Cj).

Figure 1. Remote Sensing Cluster - Closely Related Words.

Subsets of closely related words are combined into one file. Words which are common to more than one subset (cluster overlaps) are identified. Megaclusters, or strings of overlapping clusters (based on a threshold of numbers of common words, or overlaps), are constructed. These show umbrella areas of related research.

The final results identify: (1) the pervasive themes of the database; (2) the relationship among these themes; and (3) the relationship of supporting sub-thrust areas (both high and low frequency) to the high-frequency themes.

Numbers are limited in their ability to portray the conceptual relationships among themes and sub-themes. The qualitative analyses of the extracted data have been at least as important as the quantitative analyses. The richness and detail of the extracted data in the full text analysis allows an understanding of the theme interrelationships not heretofore possible with previous text abstraction techniques using index or key words.

Application of Database Tomography to FASAC Database

The FSU is a major contributor to many areas of science and technology. FASAC reports help to document and interpret these contributions. There is interest in preserving the basic science capability of the FSU. This task would benefit from improved understanding of the FSU science and technology capability.

Application of full text co-word analysis (Database Tomography) to the FSU component of the FASAC database could provide a unique perspective on the FSU science and technology capability. This database has a different structure from the databases analyzed previously. FASAC contains topical area assessments, whereas, the other databases analyzed contain program, project, or promising opportunity descriptions. Full text co-word analysis is sufficiently powerful and flexible to be applicable to FASAC as well. (Unclassified FASAC reports were used.) The FASAC database has a moderate density of technical terms. Most are scientific, but there are many institute names, journal names, publishers, and people names. Determination of the relationship among only technical areas is more difficult than in some purely technically focused databases which were analyzed previously. However, the data allows analyses which go beyond purely technical

relationships.

Multiword Frequency Analysis

The output of the multiword frequency analysis allows construction of a multilevel taxonomy of the full database. This taxonomy derives from the language and natural divisions of the database (analogous to a natural coordinate system of the database). Database entries are easily categorized. Other taxonomies are generated top-down and usually attempt to force-fit database subjects into pre-determined categories.

One advantage of the present full text approach over the index or key word approach is that many types of taxonomies can be generated, such as: science, technology, institution, journal, and person name. Within any one of these categories, such as science, many types of taxonomies can be developed. An example of one science taxonomy of the FASAC database will be shown.

Based on the high frequency single, adjacent double and triple words, the following high level taxonomy was generated. The capitalized words are sample high frequency words from the multiword frequency analyses:

1. Information: DATA, IMAGE PROCESSING, STATISTICAL PATTERN RECOGNITION
2. Physics: LASER, SHOCK WAVE, CHARGED PARTICLE ACCELERATORS
3. Environment: OCEAN, SEA SURFACE, INTERNAL GRAVITY WAVES
4. Materials: MATERIALS, THIN FILM, METAL MATRIX COMPOSITES

Caution must be exercised in relating the above taxonomy based on FASAC to the actual taxonomy of all of FSU science. The FASAC reports represent selected areas of FSU science. It is not known how representative all the FASAC reports are of total FSU science. The FASAC reports tend to reflect the open FSU literature. It is not known how well this open literature represents all of FSU science, including classified work and other unreported work.

The above taxonomy reflects frequency of word usage. It represents the numbers of words written about technical areas in the FASAC reports. Dollars spent on these areas, or other measures of FSU priorities, were not taken into account. The taxonomy could be skewed relative to FSU importance attached to these areas. Nevertheless, the above taxonomy does offer insight into areas of FSU science of interest to the U.S.

Megaclusters

Clusters which had three or more overlaps (three or more common members) were combined to form strings of related clusters, or megaclusters. The following megaclusters were obtained: Ionospheric Heating/Modification, Image/Optical Processing, Air-Sea Interface, Low Observable, Explosive Combustion, Particle Beams, Automatic/Remote Control, Frequency Standards, Radar Cross Section. Of the 60 cluster themes that were used to compute overlaps, 52 were in one of the nine megaclusters above. Most of the eight

remaining themes could be subsumed under the nine megaclusters.

The science discipline taxonomy for the FASAC database was derived from the multiword frequency analysis. It was defined as Information, Physics, Environment, and Materials. In terms of the megaclusters:

1. Information would encompass: IMAGE/OPTICAL PROCESSING, AUTOMATIC/ REMOTE CONTROL
2. Physics would encompass: IONOSPHERIC HEATING/MODIFICATION, PARTICLE BEAMS, FREQUENCY STANDARDS, RADAR CROSS SECTION
3. Environment would encompass: AIR-SEA INTERFACE
4. Materials would encompass: EXPLOSIVE COMBUSTION, LOW OBSERVABLE

Categorizing the database with the megacluster subcategories allows the re-interpretation of the FASAC database as a compendium of those aspects of FSU science of interest to the U.S. for strategic and military purposes rather than a microcosm of all of FSU science. For example, many classes of materials were researched and developed in the FSU. Yet the materials subcategory in the FASAC analysis focuses on FSU capabilities in energetic materials (explosives and propellants) and coatings to reduce radar cross sections. Both classes are important from a military viewpoint. The main environmental focus is air-sea interface. There is little mention of the terrestrial environment. The primary information category focus is on image and optical processing, and the secondary information category focus is on remote control. One could conclude that the FASAC concern was FSU capability in sensing the ocean for ship and submarine activity, and remotely processing and interpreting this information.

The secondary environmental focus of FASAC was on FSU capabilities for modifying the ionosphere through high power radio wave heating and exploiting its use as a communication medium. One focus of the physics category was particle beams. These could have dual applications of high energy directed weapons and heaters for magnetically confined plasmas and inertial fusion targets.

<u>Cluster Theme/Member Relationships</u>

The final display, Figure 2, shows high technical content words from one of the smallest of the 60 clusters. The selection cutoff criterion was an Equivalence Index (see Figure 1 for definition) greater than or equal to 0.001. A simple division of word categories into quadrants based on Inclusion Index values was used to display the relationships of the cluster members to the cluster theme and to each other.

ATMOS OCEANIC PHYS CLUSTER - HIGH TECHNICAL CONTENT WORDS

<u>HIGH Ij HIGH Ii</u>

<u>HIGH.Ij.....LOW.Ii</u>....................<u>LOW.Ij...HIGH.Ii</u>

```
     SEA..................................RADIOACOUSTIC.SOUNDING
     INTERNAL.WAVE........................ACOUSTIC.SOUNDING
     ACOUSTIC.............................THEORY.OF:WIND
     SCATTERING...........................MODELING.OF.SURFACE
     RADAR................................ATTENUATION.OF.SOUND.
SEA.SURFACE.............................INFRASOUND.AND.INTERNAL.
     ATMOSPHERE...........................THEORY.OF.WAVE

.........................LOW.Ij....LOW.Ii

     WIND.WAVES...........SHEAR.FLOW........PROCESSING.OF.RADAR
     SOUND.PROPAGATION....TURBULENT.........WAVE.PROPAGATION
     OCEAN.SURFACE........SATELLITE.........WIND.VELOCITY
     INTERNAL.GRAVITY.WAVES.................POINT.SOURCE
     STRATIFIED.FLUID.......................SOUND.WAVES
```

Figure 2. High Technical Content Words of Final Display.

In Figure 2, the underlined topic, ATMOS OCEANIC PHYS, is the cluster theme. The cluster members are segregated into quadrants headed by their values of Inclusion Indices. Ij is the ratio of Cij to Cj, and is the Inclusion Index based on the theme word. Ii is the ratio of Cij to Ci, and is the Inclusion Index based on the cluster member. The dividing points between high and low Ij and Ii are the middle of the"knee" of the distribution functions of numbers of cluster members vs. values of Ij and Ii. All cluster members with Ij greater than or equal to 0.1 were defined as having high Ij. All cluster members with Ii greater than or equal to 0.5 were defined as having high Ii.

A high value of Ij means that, whenever the theme word appears in the text, there is a high probability that the cluster member will appear within +-50 words of the theme word. A high value of Ii means that, whenever the cluster member appears in the text, there is a high probability that the theme word will appear within +-50 words of the cluster member.

Thus, words located in the upper quadrant (high Ij high Ii) are coupled very strongly to the theme word. Whenever the theme word appears, there is a high probability that the cluster member will be physically close. Whenever the cluster member appears, there is a high probability that the theme word will be physically close. Whenever either word appears in the text, the other will be physically close.

Consider words located in the left quadrant (high Ij low Ii). Whenever the cluster member appears in the text, there is a low probability that it will be physically close to the theme word. Whenever the theme word appears in the text, there is a high probability that it will be physically close to the cluster member. This type of situation occurs when the frequency of occurrence of the cluster member Ci is substantially larger than the frequency of occurrence of the theme word Cj, and the cluster member and the theme word have some related meaning.

Single words have absolute frequencies of an order of

magnitude higher than double words. Thus, the words in the left quadrant are typically high frequency single words. They are related to the theme word but much broader in meaning than the theme word. A small fraction of the time that these broad single words appear, the more narrowly defined double word theme will appear physically close. However, whenever the narrowly defined double word theme appears, the broader related single word cluster member will appear. The words in the left quadrant can also be viewed as a higher level taxonomy of technical disciplines related to the theme ATMOS OCEANIC PHYS.

Consider words located in the right quadrant (low Ij high Ii). Whenever the cluster member appears in the text, there is a high probability that it will be physically close to the theme word. Whenever the theme word appears in the text, there is a low probability that it will be physically close to the cluster member. This type of situation occurs when the frequency of occurrence of the cluster member Ci is substantially smaller than the frequency of occurrence of the theme word Cj, and the cluster member and the theme word have some related meaning. Thus, the words in the right quadrant tend to be low frequency double and triple words, related to the theme word but very narrowly defined.

A large fraction of the time that these very narrow double and triple words appear, the relatively broader double word theme will appear physically close. However, a small fraction of the time that the relatively broad double word theme appears, the more narrow double and triple word cluster member will appear. This quadrant grouping has the potential for identifying "needle-in-a-haystack" type thrusts which occur infrequently but strongly support the theme when they do occur. One of many advantages of full text over key or index words is this illustrated ability to retain low frequency but highly important words, since the key word approach ignores the low frequency words.

The words in the bottom quadrant (low Ij low Ii) are the remainder of the culled words. They relate to and support the theme, but do not have the strong inclusions based on theme or cluster member occurrence of the members of the other quadrants. The upper quadrant typically contains very few or no words. The left quadrant contains very broad words related to the theme. The right quadrant contains extremely narrow words related to the theme. The bottom quadrant contains words related to the theme of the same level of specificity as the theme (on average).

Figure 2, ATMOS OCEANIC PHYS, has a null upper quadrant (typical of the majority of clusters for the threshold values of Equivalence index chosen). The left quadrant, the broad taxonomy of related areas, appears to describe two major thrusts:

1. Underwater related (SEA, INTERNAL WAVE, ACOUSTIC, SCATTERING) focusing on sound propagation through the sea.
2. Atmosphere related (ATMOSPHERE, RADAR, SEA SURFACE, SCATTERING) focusing on radar propagation through the atmosphere.

The thrusts have a common juncture at the sea surface, where

both acoustic and radar scattering occur on different sides.

The right quadrant focuses on very specific subareas related primarily to acoustics. These include acoustics applied to the atmosphere (RADIOACOUSTIC SOUNDING), and other aspects of atmospheric science (THEORY OF WIND).

The bottom quadrant provides the most balanced view of the two thrusts. It expands on the underwater propagation medium (STRATIFIED FLUID, SHEAR FLOW, INTERNAL GRAVITY WAVES), the radar platform issues (SATELLITE, PROCESSING OF RADAR), and the ocean surface issues (WIND WAVES, TURBULENT, OCEAN SURFACE). The integrated picture presented by the three quadrants is the use of radar from a space platform to view the ocean surface, and the research problems arising from the wind and undersea flows governing the conditions and structure of the ocean surface and impacting the interpretation of the radar images.

CONCLUSIONS FROM DATABASE TOMOGRAPHY STUDY

Based on the results and interpretation of the multiword frequency analysis and the co-word analysis, the FASAC database used in this study is a compendium of those aspects of FSU science of interest to the U.S. for strategic and military purposes. The microlevel analysis of selected theme clusters, showing how the cluster members related to each theme, reinforced this conclusion and provided more detail about those aspects of each theme on which FASAC concentrated.

A wealth of information resulted from the FASAC output, and only a small fraction of that information was presented and analyzed in this study. The analysis was restricted to technical themes and their relationships. Raw data was available for relating technical themes to non-technical themes such as institutions, scientists, journals, and geographical regions.

In the future, full text co-word analysis could be used to obtain a more representative structure of FSU (or any other country's) science. If a large number of randomly selected published FSU scientific papers were entered into a database, then a multiword frequency analysis and co-word analysis could be performed on this text database.

Assume that a paper represents about $100K worth of effort. A 10,000 paper database would represent $1B worth of effort, and would offer a very representative sample of FSU science output. The 10,000 paper database could be analyzed on an existing advanced desktop computer. The critical path would be assembling this database, not analyzing it.

Full text co-word analysis is in its formative stages. Much development remains to be done to understand the breadth of analyses which can be performed and the breadth of applications which can be covered.

NETWORK MODELING FOR DIRECT/INDIRECT IMPACTS

Background

In a mission-oriented research-sponsoring organization, the selection and continuation of research programs must be made on the basis of outstanding science and potential contribution to the organization's mission. There have been increasing pressures to link science and technology programs and goals more closely and clearly to organizational as well as broader societal goals [Carnegie, 1992]. The process of estimating **potential impact** of research, especially basic research, on organizational and societal goals is complex due to the myriad of pathways by which the research product can effect its impact.

Most resource-allocation methods in the literature that incorporate organizational objectives tend to be **qualitative** when addressing **basic research**, and more **quantitative** when addressing **applied research** allocation.

-(See Logsdon [1985], OTA [1986], Hall [1990], IEEE [1974, 1983], Baker [1964], Cetron [1967], Datz [1974], Baker [1974, 1975], Winkofsky [1980] for **reviews** which compare selection methods and sort these methods into categories or classes;

-see Kostoff [1983], Hazelrigg [1982], Helin [1974], Souder [1978], Cook [1982], Nutt [1965], Souder [1975], Van de Ven [1971], Plebani [1981], Mottley [1959], Garguilo [1981], Gear [1971], Pound [1964], Dean [1965], Moore [1969], Gustafson [1971], McGuire [1973], Paolini [1977], Cooper [1978], Ramsey [1978], Krawiec [1984], Gear [1974], Keefer [1978], Madey [1985], Liberatore [1987], Dean [1962], Cramer [1964], Vanston [1977], Bell [1967], Cochran [1971], Themelis [1976], Aaker [1978], Liberatore [1981], Silverman [1981], Menke [1983], Ellis [1984], Hertz [1964], Hespos [1965], Maher [1974], Schwartz [1977] for **benefit measurement** methods [develop quantitative measures of the benefit of performing an R&D project, then select those projects which provide greatest benefit] as defined in Hall [1990];

-see Watters [1967], Asher [1962], Beged Dov [1965], Baker [1969], Souder [1973], Keown [1979], Winkofsky [1981], Taylor [1982], Hess [1962], Rosen [1965], Atkinson [1969] for **constrained optimization** approaches [optimize some objective function subject to specified resource constraints] as defined in Hall [1990];

-see Cooper [1981], Stahl [1983], Lockett [1970], Mandakovic [1985] for **cognitive emulation** models [establish an actual model of the decision making process within an organization] as defined in Hall [1990])

Almost all of the allocation techniques in the literature are more appropriate for the applied research, or development, projects. Use of R&D project selection models falls into three categories [Roessner, 1985]:

1. A decision maker was influenced on a particular decision by the findings of a specific piece of research (instrumental use);
2. A decision maker finds that a piece of research contains ideas or information that contribute to the work of his/her organization (conceptual use);
3. A decision maker uses research to advance his/her own self-interest (partisan use).

Whether these allocation techniques are categorized according to OTA [1986] (scoring models, economic models, constrained optimization models, risk analysis models), or categorized according to Hall [1990] (constrained optimization methods, benefit measurement methods, cognitive emulation models, ad hoc methods, surveys) these techniques require, in practice, a project's **development and payoff** characteristics. These characteristics can be estimated when a project's downstream development phase can be identified, such as for some types of applied research, and for many types of development projects. For many areas of basic research, development and payoff characteristics are not obvious. There do not appear to be viable quantitative resource allocation models applicable to basic research.

This section discusses a network based modeling approach which would allow estimation of the direct and indirect impacts of a research program or collection of research programs. The research program impacts would be multi-faceted, including impacts on advancing its own field, on advancing allied fields, on advancing technology, on supporting operations and mission requirements, etc. The model proposed here differs from any reported in the literature in that it reflects more accurately the different types of impact which basic research generates. A major feature of the model is **inclusion of feedback from the higher development categories (e.g., exploratory development, advanced development) on the advancement of research.**

Philosophy of Proposed Network Approach

Existing matrix-based research impact models [Dean, 1972; Ibrahim, 1984]) are most useful for applied R&D concepts and utilize a **vertical impact structure (forward diffusion of knowledge) where the impacts of research flow forward only to the more advanced development categories (e.g., research----> development----> systems)**. The proposed model uses a structure of **lateral and backward diffusion of knowledge superimposed on the vertical impact structure (e.g., research----> research----> development----> research----> development----> systems).** The proposed model accounts for the upward impacts of research (forward diffusion) allowed by the present models. It also allows one research field to impact another research field (lateral diffusion) and allows the higher development categories to impact research as well (backward diffusion).

For example, a matrix model approach could have a vertical impact structure path consisting of Physics (research) impacting Lasers (technology) impacting Beam Weapons (systems). The proposed network model would include this path, but many others as well, including Physics (research) impacting Lasers (technology) impacting nanoelectronics (research) impacting Controls (technology) impacting Beam Weapons (systems), and including Physics (research) impacting Lasers (technology) impacting Fluid Flow Visualization (research) impacting Helicopter Blade Design (technology) impacting Helicopters (systems).

The impact of much basic research, especially on the higher development categories such as systems development, proceeds through many indirect paths. A quantitative model of impact should have the capability of identifying the paths along which impact occurs and quantifying the impact along as many paths as is possible. The existing forward diffusion matrix-based models are severely constrained on the number and types of paths along which impact occurs. These models are **not** able to account for impact along **lateral diffusion** paths (e.g., research-research) or along **backward diffusion** paths (e.g., technology-research). The proposed model allows impact to occur along any of these paths, and thus includes many types of indirect impacts as well as direct impact.

Example: Differences between Matrix and Network Approaches

A simple example will show the difference in breadth of impact allowed between the proposed model and a leading existing matrix-based model [Dean, 1972]. Assume it is desired to compute the impact of a research project R on a technology project T. In the standard methodology, it is only necessary to examine **ONE** path from R to T. This is the path of direct impact, and the value of the impact is the value of the matrix element RT.

In the proposed methodology, R and T are two nodes in a fully connected network. All possible paths between R and T are examined when computing the total impact of R on T. Thus, the overwhelming **majority** of paths which contribute to the **total impact** of R on T are the **indirect impact paths.** The total impact of R on T is the sum of the link value products along **EVERY** path connecting R to T. Continuing the example above, R could be the Physics research node and T could be the Laser technology node. In the standard matrix approach, only the direct impact of Physics on Lasers is considered. In the proposed methodology, additional paths between Physics and Lasers, such as Physics impacting Fluid Dynamics research impacting Lasers or Physics impacting Solid State Materials research impacting Lasers, would also be considered.

For a graph with a large number of nodes N, there are approximately e*m! paths (ranging in length from 1 to N-1 links) connecting R to T, where m is N-2. In the pilot study performed to test the validity of the proposed model and overviewed in this Handbook, the graph that was used consisted of 15 research nodes and 27 technology nodes. For the pilot study graph, e*m! is approximately 10 to the 47th power. In this simple example based on the **small** pilot study grid, the proposed method could theoretically examine link value products along **47 orders of magnitude** more paths than does the standard method. In the actual pilot study, link value products were computed along all paths five links or less in length. This means that approximately m^4, or 2.5 million paths connecting R to T, were examined. This same order of magnitude differential holds between the proposed method and the other matrix-based methods which were examined before the proposed method was devised.

Of equal importance to the **quantitative** difference between the two methods is the **qualitative** difference. The proposed approach

allows **full weight** to be given to those research projects which have **large indirect** impacts. Many of the fundamental research areas, such as Mathematics, Physics, etc., have substantial impacts on other research areas (as well as technologies), and these indirect impacts are not fully captured in the matrix-based methods. Since the fundamental research areas tend to have indirect impact on many research and technology areas, when the impact is summed over all research and technology areas, the **total impact of these fundamental research areas becomes substantial.**

For any organization with a substantial fraction of its budget in these fundamental research areas, a method that is able to capture the sizeable indirect impacts of basic research is important. For an advanced technology development organization, where the impacts of the work are more focused to specific technologies and requirements, the benefits of the proposed multipath approach may be less (although they will always be greater than those of the matrix approaches, since the proposed method includes all the paths in the matrix approach and others).

The remainder of this section describes the proposed method, an overview of the preliminary pilot study that was performed to test the feasibility of the method, key lessons learned from the pilot study, and recommendations for an enhanced study.

METHODOLOGY

Creating Domains and Forming the Network

The research impact quantification methodology presented here displays the value of a given research program to advancing its own field, to supporting other research areas, to supporting technology, and to supporting mission requirements. The first step in the methodology is defining a domain of potential impacts. For example, if the impact of research on other research, technology, and systems is desired, then the three-level domain for the model would be research, technology, and systems. Each of these levels is subdivided further into a number of categories.

As a specific example, in the two-level domain (research, technology) pilot study that will be overviewed, research was divided into 15 categories (math, physics, chemistry, etc.) and technology was divided into 27 categories (training, navigation, countermeasures, etc.). These categories had the property of being relatively non-overlapping, and were similar to categories being used by the Navy for management purposes at the time of the study. All 42 categories are represented as nodes in a network.

Since it is assumed that research, technology, and missions are interlocked and have mutual impacts with different strengths of connectivity, each pair of categories (nodes) can be visualized as connected with a line (link). This schematic has the form of a graph, or network in which all node pairs are connected. The lines, or links, which connect each pair of nodes, are allowed to have two values, depending on direction between the nodes. This allows any research, technology, or missions area at the lowest category breakdown level to impact any other research, technology,

or missions area with a specified strength.

Since one of the desired outputs of the proposed procedure is impact of research, and since research, technology, and missions are assumed to have mutual impacts, then the generic computational problem is to obtain the impact of one node of the network on any other node in the network. Three interrelated types of impact (**DIRECT IMPACT, IMPACT, TOTAL IMPACT**) of one node on any other node will now be described.

In this multi-node network, assume 'a' is one node, 'b' is a second node, and 'x' is a third node. The **DIRECT IMPACT** of node 'a' on node 'b', or more specifically, the direct importance of results from node 'a' to the achievement of objectives of node 'b', is the value (L ab) of the link directed from node 'a' to node 'b'. Thus, if 'a' represents a research node (partial differential equations, for example), and 'b' represents a technology node (short wavelength lasers, for example), then (L ab) would represent the direct importance (or **DIRECT IMPACT**) of research results in partial differential equations to the achievement of development objectives of short wavelength lasers. The scale of (L ab) ranges from 0% importance, which means results from node 'a' have no impact on achievement of objectives of node 'b', to 100 % importance, which means results from node 'a' are absolutely crucial to the achievement of objectives of node 'b'.

The **IMPACT** of node 'a' on node 'b', along any multi-link path connecting node 'a' to node 'b', is defined as the product of the link values (**DIRECT IMPACTS**) along the path. On the two link path 'a'-'x', 'x'-'b', the **IMPACT** is the product (L ax * L xb). Thus, if results from work in node 'a' are 25% important to obtaining objectives in node 'x', and results from work in node 'x' are 25% important to obtaining objectives in node 'b', then the IMPACT of node 'a' on node 'b' along the two link path 'a'-'x', 'x'-'b' is 6%. Other functions to represent **IMPACT** along the multi-link path could be defined, but the product of link values appears to be simplest and easiest intuitively to relate to reality.

The **TOTAL IMPACT** of node 'a' on node 'b' is defined as the sum of the **IMPACTS** along every path connecting node 'a' to node 'b' and is the main figure of merit used in the present study. The computational problem for obtaining **TOTAL IMPACT** of node 'a' on node 'b', then, is to trace each path from node 'a' to node 'b', compute the link value products along each path to obtain the **IMPACT** of 'a' on 'b' along the path, and sum the **IMPACTS** over all the paths connecting node 'a' to node 'b'. To eliminate double counting, and to insure that the **IMPACT** of node 'a' on node 'b' decreases as more links are added to the particular path connecting node 'a' to node 'b', the values of all the links coming into node 'b' should not exceed unity.

Normalizing Link Values

This condition is incorporated into the computational process by using a normalized value for each link value in place of the value provided by the data source; i. e., L' ij = L ij * (1 - L jj)/SUM (L ij) where L ij is the data source link value, L' ij is

the normalized link value, L_{jj} represents the fraction of the objectives within node 'j' that can be achieved without input of results from any other nodes in the network, and the sum is taken over all the links coming into node 'j'. The equations without further constraints allow loops to exist in the network. For example, a three link path between node 'a' (Math) and node 'b' (Lasers) could be node 'a' to node 'x' (Physics), node 'x' to node 'a', and node 'a' to node 'b'. While this would be viewed as double counting if it were to occur at one point in time, it is perfectly valid when these steps among nodes occur at different times. Thus, the **IMPACT** of node 'a' on node 'b' has to be interpreted as a cumulative impact over time and is a function of the length of the path from node 'a' to node 'b'. An exact solution for the **IMPACT** would therefore require link values for every step in time from the present to the computational time horizon. Further, each of these link values could not be obtained independently, but would require knowledge of the link values connecting all the nodes at the previous time step, since progress in any one node is assumed to depend on previous progress in all of research and technology. To keep the computational and data generation problem manageable, an approximate solution is obtained by treating the link values as constants rather than functions of time, and interpreting and providing the link values as time-averaged quantities. Without knowledge of the variation of the link values with time, a credible estimation of the error resulting from the constant link value assumption cannot be made.

PILOT STUDY OVERVIEW

Taxonomy Used

It was the author's intent to identify the pathways through which research programs could impact technology areas and eventually naval and other application or mission areas. In parallel, some quantification of the impact of these programs was desired. A complete study would have required hundreds of nodes, many experts or other sources of the raw link value input data, and large amounts of data handling and entry. As a first step, to test the feasibility of the overall method, a small-scale pilot study was performed. Research and technology levels were included in the computational network; missions were not included. The final research taxonomy selected for the study was identical to the categorization which the Office of Naval Research used for research management purposes at the time of the study. The final technology taxonomy selected for the study was similar to functional element breakdowns used in the past by Navy exploratory development programs for management purposes. These two taxonomies had the virtue of being fairly comprehensive in their coverage, at least as far as the Navy is concerned, and there were in-house experts available to provide preliminary link value data for each of the subcategories in these taxonomies. Of necessity, the taxonomy elements used were very broad. Each research taxonomy element (e.g., Mechanics) contained a number of different research programs

(e.g., Solid Mechanics, Fluid Mechanics, Energy Conversion), which themselves could have been divided into subprograms.

Data Acquisition

The data was obtained by personal interview. Each in-house expert was provided with a list of the 42 research and technology nodes, and was asked to estimate the importance of results produced from all the other nodes on his particular node of expertise. The expert was asked to provide a number which served as a measure of impact based on the following scoring scale: Crucial(10); Very Important(8); Important(6); Moderately Important(4); Slightly Important(2); Negligible(0). Definitional uncertainties were minimized due to the presence of the interviewer.

Because the approach is based on subjective judgement, there are limitations to the validity of the data, especially with the small numbers of experts per node that were employed. There was no attempt made to normalize the responses, and an impact that one expert labeled Important could have been labeled Moderately Important by another expert. There was no attempt to gauge the degree of expertise of each respondent relative to his field of expertise, and the numerical ratings supplied, therefore, carry different degrees of validity. Because of the broad discipline coverage of each node, the expertise of any respondent relative to the breadth of the discipline was quite limited. Use of a small number of experts per node did not provide a good statistical representation of how each technical community would have perceived impact on its discipline.

Because of the rapid convergence of the link fractional value multiplication process, it was found that timely and accurate results could be obtained with networks whose longest paths were three links in length. Including a fourth link made only a very few percent difference in the results.

Lessons Learned from Pilot Study

The results from the pilot study are described in detail in Kostoff [1994i]. The lessons learned from the pilot study will now be described. The pilot study was limited by a number of factors, especially the broad coverage of each node. To expand the scope and capabilities of the study methodology to the point where study results could support credibly the prioritization of research areas and produce a more evidentiary basis for establishing program balance, the following steps would be required at a minimum.

First, the research and technology nodes need to be subdivided to improve resolution. The second major improvement required over the pilot study is the addition of missions nodes to the network. The third improvement is that research, technology, and missions taxonomies need to be orthogonalized better, so that overlaps among nodes and resultant skewing of the results are minimized. Fourth, the number and range of experts per node need to be expanded to provide more node representative than the one or two experts per node provided in the pilot study. The fifth improvement is that the written material supplied to the respondents needs to be

sharpened, especially in the absence of an interviewer.

Operational Value of Present Approach

The final issue in this section addresses the operational value of the present approach. When the pilot study was proposed, the type and significance of results finally obtained were never expected. As the study proceeded, much information about the interlocking nature of research and technology was obtained in addition to that provided on the questionnaires. Thus, much of the study's value derived from the performance of the study, and additional study benefits would be expected from a refined study.

From another perspective, a refined study could serve as a total program assessment. It could identify gaps, duplications, promising research areas, and funding priorities for the total program taken as a whole. The typical technical assessment performed today focuses on a technology or research area, and defines required research to allow attainment of technology and mission objectives. However, in the zero-sum game environment of finite resource constraints, money to fund the required research identified by the assessment has to be taken away from proposed or existing research in some other area. Unless the total impact of unfunding this other research can be identified, it is not clear whether the overall research program would benefit by funding that research identified by the technology assessment. In fact, it is evident that unless all technology and research are assessed simultaneously, funding reallocations based on one or two specific technology assessments could be highly suboptimal and misleading and could affect the overall research program adversely. A refined study could serve as a total research and technology assessment, performed at the project level, and may perhaps be the only sensible way to perform a technical assessment.

NETWORK MODELING FOR ROADMAPS

This section includes contributions from MR. ROBERT J. ZURCHER AND DR. RONALD N. KOSTOFF.

Introduction

One of the motivations for research assessment and evaluation studies is to gain a better understanding of the potential myriad impacts of the research, and then use this understanding to help accelerate the transition of the research to useful technology. Accelerating the conversion of science to technology has three essential elements: 1) Information about the science must exist and be readily available to potential users; 2) The need for the converted science (technology) must exist; 3) One or more entrepreneurs who recognize the need, who understand the relationship between the need and the science, and who are willing to obtain the necessary resources and accept the risks inherent in further development of the science, must be available to champion its further development.

Large databases, which describe ongoing and completed

research, are commercially available (e.g., journal paper abstracts, federal project and program narratives). With global competition for markets, the need for new technology has never been greater, and many compendia of projected technology requirements are available (National Academy of Science/Engineering Studies, Agency Requirements Documents, etc.).

However, availability of research and requirements information is not sufficient to motivate potential entrepreneurs to invest time and other resources in the high risk research conversion process. Investors must be convinced that the considerable front-end risk of science conversion is more than justified by the potential payoff. Placement of the science conversion step into the larger pathway from research to high-payoff applications is a key component for eliciting investor interest. While relatively large resources have supported the development of the research databases, and substantial study efforts and market surveys have contributed to the volumes of existing requirements, relatively few efforts have focused on fusing together requirements with research systematically.

There are fundamental reasons why little progress has been made on methodologies to identify the characteristics of these linkages. The pathways between research and eventual applications are many, are not necessarily linear, and require significant amounts of data [Kostoff, 1994i; previous section on network modeling]. Substantial time and effort are required to portray these links as accurately as possible, and substantial thought is necessary to articulate and portray this massive amount of data in a form comprehensible to potential investors. Recently, desktop high speed computers with large storage capabilities, intelligent algorithms for manipulating data, and other tools have become available to allow these research-capabilities pathways (roadmaps) to be constructed and portrayed efficiently and effectively, and to be used as a basis for more detailed analysis.

The main value of these decision aids, or roadmaps, in the science conversion process is to promote, at all phases of the roadmap development process, champion/ investor interest in developing the research further. In planning the roadmap, thought has to be given to all its structural elements, including the extent of the development required, any trade-offs or opportunities lost, and potential costs and payoffs. In building the roadmap, experts in the different levels of development and payoff become involved, and the risks, potential costs and benefits are clarified further. When the completed roadmap is distributed to interested parties, decisions to pursue the science conversion can be made with greater understanding of the larger development context. For a more comprehensive discussion of roadmaps, see Science and Technology Roadmaps [Kostoff, 1997p] on the Internet.

Retrospective studies of successful innovation have shown that at least one champion is required to insure continuity and persistence toward the final goal [Kostoff, 1997j]. Other studies have shown that two champions are preferable, one from the technology-push side and the other from the requirements-pull side

[Rubenstein, 1997]. In reality, there are at least three major parameters which govern the role and impact of champions on the science conversion process. The first is numbers: the more champions, the more likely is the conversion process support. The second is intensity: the more intense the interest and persistence of the champion(s), the more likely is the research to proceed. The third is influence: the greater the influence of the champion(s), the more likely are the chances that the research conversion will be pursued.

Having potential champions involved in the planning, developing, and distribution of the roadmap improves the likelihood of numbers, intensity, and influence of champions being increased if analysis of the roadmap shows downstream potential for substantial payoff. If roadmap analysis does not show convincing evidence of payoff of the research toward the objectives, either due to intrinsic lack of potential payoff or to unawareness of payoff of those constructing the roadmaps, then the research may not proceed further. If the roadmap analysis shows high potential payoff, but with extremely high front-end risk and costs, then the type of champion interest may be limited to government for the initial risk-lowering development phases.

This section overviews the algorithmic component and analytic potential of the Graphical Modeling System (GMS), a computer-based process for generating and analyzing roadmaps which link research to technology and eventually to capabilities/requirements. This process has been under development for the past five years [Zurcher, 1997], and its algorithmic component is based on a directed graph/ network model of research/technology/capabilities/ requirements. It uses the latest relational database/ hypertext technology to identify the potential pathways which link research to higher development categories and specific requirements/ targets of interest. The algorithmic component presently resides on a PC and requires 16Mb ram, 5Mb of disk storage, and a minimum of ½Mb of disk storage for an uncomplicated technology roadmap.

In the past, many methods have been developed to select or evaluate R&D projects [Fahrni, 1990; Cooley, 1986; Jackson, 1983; also see references in previous section on Network Modeling]. These methods typically use simple checklists, scoring, cost/benefit analysis, mathematical programming or decision trees to determine future value from a current investment. Other methods describe the value of R&D projects by attempting to measure the effectiveness of transfers of technology [Spann, 1995] without explicitly taking into account customer requirements. Some algorithms link research programs to end uses/ capabilities/ requirements [Thomas, 1996; Barker, 1995]. This last method 1) creates a context within which technology projects exist, 2) requires a flexible technology assessment methodology since requirements change and emerging technologies will modify current plans, and 3) demands continual dialog between customers and developers. As shown in the previous section on network modeling, in the classical matrix approach [Dean, 1972], impacts flow monotonically upward in the development chain (research -->

technology --> capabilities --> requirements/end targets), and in the network/ directed graph approach [Kostoff, 1994i], impacts are allowed to flow upward, downward, or laterally in the development chain (e.g., research --> technology --> research --> research --> technology --> capabilities). GMS is able to show the node-link relationships of both the matrix and network approaches (where a research or technology project, or a capability, is treated as a node in a network, and the impact of one project [node] on another project [node] is portrayed as a quantified link in the network).

In addition, GMS adds a crucial new capability, termed Multiple Perspectives (MP). In GMS, the nodes (projects/ capabilities/ requirements) are treated as multi-valued (multi-attributed) quantities, and are allowed to exist in many different research-requirement pathways simultaneously. This MP capability provides a more accurate depiction of the multi-application nature of most research and technology. The user of GMS is now able to highlight only the specific node-link subnetworks of interest (the desired research-requirement pathways) without being overwhelmed by the massive data which constitutes the larger network.

For example, the MP capability enables the user to select research-requirements pathways to view (e.g., 'top-down' requirements perspectives, or 'bottom-up' science/technology perspective rather than viewing all, potentially complicating, nodes and links, or having a static display that can not change). Researchers can 1) observe the larger context in which their work is being performed, or 2) identify new applications' targets for their research, and make informed decisions on how to proceed to maximize payoff for multiple applications. Also, it allows the user and other interested parties to identify the research and technology projects which presently serve as obstacles to reaching desired applications' targets in a timely manner.

Methodology

The roadmap, or graphical model, overviewed here is a selected set of requirements, links and R&D projects that describes the state of technology development and potential transfer in a coherent area. It could be composed of a single requirement for a system linked to corresponding R&D projects, or it could encompass multiple requirements linked to numerous projects. A graphical model visually portrays; requirements, capabilities, R&D projects in different development phases; relationships between R&D projects and requirements; and integration among related R&D projects.

The GMS depiction of the science conversion process is assembled in a two-stage process: 1) Construction of a graphical model; 2) Analysis of the pathway elements between requirements and R&D projects.

a. Model Construction:

Model construction consists of identifying the projects and requirements (nodes) for the roadmap, then identifying the

relationships (links) between the projects and requirements.

Step 1: Identifying Types of Projects and Requirements

R&D projects and requirements are partitioned according to the phase of development of the R&D projects and to the level of specificity of the requirements. While the actual graphical models used employ a half-dozen or more bands for subdividing project and requirement types, for purposes of demonstration simplicity the roadmaps shown in Zurcher [1997] have four levels: research, development, capability, requirements.

Constructing the roadmap framework (i.e., identifying the specific nodes to be used in the roadmap and the placement of those nodes at the appropriate level of development) is perhaps the most challenging step in the roadmap development process. It is somewhat paradoxical in that the appropriate expertise must be employed to develop a roadmap, but the appropriate expertise becomes fully known only after a complete roadmap has been constructed. An iterative roadmap development process is therefore essential. For an organization in which many of the roadmap components are being pursued in-house, such as a large focused government or corporate laboratory, much of the expertise can be assembled in-house. Researchers, developers, marketers and others with relevant knowledge of the overall roadmap theme can be readily convened to develop the framework. At the other extreme, organizations with little expertise in the overall roadmap theme, such as venture capital groups or cash-rich organizations that wish to expand their boundaries, will require external assistance to develop credible roadmaps.

The utility of a roadmap increases as it expands to include potentially relevant R&D performed in all sectors of the technical community. The experts constructing the roadmap can draw upon their personal experience and contacts in identifying other R&D performed in the community, and should utilize computerized resources such as program narrative databases to identify relevant external R&D. The quality and credibility of the roadmap increases as more experts are employed in its construction. While it is preferable to have at least one expert in each node technical area (e.g., if ELECTRO-CHEMISTRY RESEARCH is one node, then at least one expert in this area should be part of the roadmap development team), useful roadmaps can be constructed with fewer contributors of broader expertise.

Experience has shown that major benefits accrue during the iterative process when the experts are convened to develop the framework. The roadmap serves as an important component of both strategic planning and technological forecasting for the organization, and forces the developers to clarify conceptual strategic targets in order to represent them graphically. Awareness of all the contributors to R&D required and R&D available in other sectors of the technical community is increased, sometimes dramatically. In particular, critical path research can be identified, and support for its accelerated

development can be strengthened. The main value at this phase is to the developers themselves; additional value accrues when the completed roadmap is provided to external users.

Step 2: Identifying Links Between Projects and Requirements

Once the full complement of nodes has been identified, the next step is to graphically and quantitatively depict the relationships among the nodes. One node is represented as linked to another node when the results emanating from the first node are assumed to have some impact on the achievement of targets of the second node. This relationship is depicted graphically by a line, or link, connecting the two nodes, and is quantified by assigning a value to the link (e.g., Kostoff, 1994i). It is important that node experts from both ends of the link (the results generator node and the results user node) are involved in assigning the link value. Finally, the inherent hypertext capabilities of GMS allow more descriptive information about each node and node-connecting link to be accessed at the touch of a button. These hypertext capabilities allow the rationale for the selection of each node, and selection of node and link values, to be obtained easily, and thereby provide deeper insight to the potential obstacles and impediments to successful research development and transition.

It is assumed that the experts in the node thematic areas are most qualified to assign values to the links entering and exiting their particular nodes of expertise. Experience has shown that most credible impacts are nearest-neighbor (e.g., basic research node outputs tend to impact applied research nodes; applied research node outputs tend to impact early development nodes). The impact of research on far-neighbor nodes, such as advanced technology projects, tends to occur along pathways consisting of nearest-neighbor steps. Thus, the developed network consists of individual node-link subnetworks, each of which has been assigned node and link values by appropriate experts.

Conceptually, however, the developed network is greater than the sum of its nodes, just as the living human body is greater than the sum of its component molecules. The developed network includes the intelligence or inherent logic, as quantified by the link values, which connects the nodes to each other and to the overall mission goals, just as the living human body includes the intelligence which links the molecules to each other and to the homeostatic operation of the body. As a result of the expert intelligence applied to quantifying each node value as well as the entering and exiting link values, there are at least two new crucial pieces of information provided by the developed network: 1) The strength of the relationships among the projects/ capabilities/ requirements and the subsequent identification of high obstacle and low obstacle paths; 2) Identification of R&D projects being conducted external to the organization, their importance to successful attainment of the organizations goals,

and their potential for leveraging by the organization. Even when node experts have not been identified or cannot be obtained, valuable information about gaps in expertise availability has been generated. The developed network with its enhanced information content now serves to promote communications among all the participants and provide a stronger basis for credible analysis and decisionmaking.

b. Model Analysis

A variety of analyses can now be performed, limited only by the interests and imagination of the analysts. The quantified network, which contains a comprehensive collection of nodes, can serve as the foundation for detailed economic studies, broad systems studies, and parametric tradeoff studies. The initial utilization of the network should serve to foster internal communications and consensus, in preparation for these more detailed analyses.

Obviously, the breadth of information obtained from the different perspectives will be limited by the contents of the total database. In an ideal world, all existing and proposed R&D programs would be entered in the overall database, and the full impact on technology and capabilities of existing and proposed research programs would be identified. In addition, the total R&D available to address required goals and capabilities would be displayed. Because of all the potential node-link combinations, and the attendant enormous amount of data required (Kostoff, 1994i), constructing this complete database is not feasible at present. However, the central thesis of the present paper is that subsets of the total database embedded in the larger analytical process still have substantial value. The existing GMS has a total R&D database constructed from the different specific mission application perspectives which have been performed, and increases in value for an organization as more perspectives are generated.

The value of graphical models is that they show R&D projects and requirements in context rather than in isolation, they can depict new perspectives rapidly, and they can serve as a focal point for enhanced communications and more detailed total systems analyses. Since the context of graphical models is different for each perspective while still using common elements (projects, capabilities, requirements), comprehending a broad R&D program and associated requirements is very difficult without the ability to sort out these elements and how they relate to one another.

Summary and Conclusions

Transferring technology to customers efficiently through a succession of autonomous development groups requires extraordinary coordination. There are many opportunities for technology transfer to become stalled at any point along the way by disparate priorities among many groups. Depicting potential science conversion in a graphical model discloses to the

scientists and investors alike the possible transfer points where obstacles may occur to technology transfer or requirements specification [Geisler, 1995].

The benefits of graphical modeling include: 1) showing R&D projects and requirements in context rather than in isolation, 2) multi-attributed nodes which can portray different research-requirement pathways rapidly, 3) serving as a focal point for enhanced communications and more detailed total systems analyses, 4) promoting champion/investor interest, 5) portraying R&D programs as being strategically planned, 6) portraying leveraging of R&D projects from other organizations, 7) identifying obstacles to rapid and low-cost technology development.

EXPERT NETWORKS

Research Impact Assessment is, at its essence, a diagnostic process with many diagnostic tools. In other fields of endeavor, such as Medicine and Machinery Repair, expert systems are increasingly being used as diagnostic tools or as support to diagnostic processes. Recently, there have been efforts to develop expert system approaches combined with artificial neural networks (expert networks) for use in R&D management, including RIA [Odeyale, 1993; Odeyale and Kostoff, 1994a, 1994b]. These efforts will be summarized in this section. Much of the remainder of this section was contributed by Dr. Charles Odeyale, a true visionary in the application of Expert Networks to the broad area of R&D management.

Overview

To increase the degree to which rationality is used to guide decisions, the authors' efforts have been directed towards a comprehensive R&D management tool, a high-tech Peer Review, through a modified version of a previous Office of Naval Research review process. The product of these efforts is Research-Management Expert Network (**R-MEN**) which is characterized by two complementary tools: Organizational/Professional Development and Expert Network. The latter technology is comprised of an expert system (left side brain) and an artificial neural network (right side brain). Given a set of research, and research management policies and strategies, **R-MEN** learns concepts that hierarchically organize those policies and strategies and use them in classifying/triaging research proposals. A brief and non-technical description of how this knowledge technology would foster continuous "learning", improve value and efficiency, increase productivity, and provide excellent performance measures of activities is presented.

Introduction

There is much concern about improving the health of basic research. The increasing politicization of the support of research has awakened many organizations to the risks and

realities of survival. There is a growing sentiment that it is no longer enough that research just be excellent, or generate new information; research must contribute results aimed toward national goals. Research and Development (R&D) administrators and managers need a powerful management tool to enable them to predict, assess and monitor the impact(s) of research results and research management processes at the project, program, organizational, and national levels.

As administrators and managers struggle to establish policy/strategy that balance cost issues with research outcomes, establishing systems to predict, assess and monitor the impact(s) of research results and research management processes should be an important consideration. The authors have discovered that successful outcomes-management systems require five basic components, namely, openness-to-change, specification process, information/ knowledge technology, measurement instruments, and continuous learning and improvement. For greater processing power, immediate access to information, and powerful applications that monitor, analyze, and manage, the authors have reported [Odeyale, 1993; Odeyale and Kostoff, 1994a, 1994b] a technology whose functionalities surpass these requirements. This value and efficiency improvement technology, which is a comprehensive computer-based Research Impact Assessment (**RIA**), is characterized by two compound mutually complementary tools: Organizational/ Professional Development (**O/PD**) and Expert Network (**EN**).

The framework of Research-Management Expert Network (R-MEN) was reported by Odeyale and Kostoff in the references cited above. It consists of a knowledge base and a data base. Feeding into the knowledge base are four modules: a policy/ strategy impartation module and a proposal data acquisition module, both of which receive input from the O/PD process; and a research impact calculation module and a proposal review module. The knowledge base then feeds into the data base through five modules: a project selection module, resources allocation module, project evaluation and control module, investigator evaluation module, and organization evaluation module.

Within the framework of Research-Management Expert Network (**R-MEN**), **O/PD** pertains to the relevance, transferability, and system alignment of the training and development efforts of each and every individual in the organization. Most importantly, these criteria of timely selection, training and development of individuals are taken in conjunction with changes in organizational environments and requirements. Through **O/PD**, attitudinal, behavioral, procedural, policy, and structural barriers are uncovered and "removed" to enable effective performance at all levels. To effectively manage this continuous "learning", improve value and efficiency, increase productivity, and provide excellent performance measures of activities, an information/knowledge technology is needed. All these needs, and more, are met by the **EN** which is comprised of an expert system (left side brain), and an artificial neural network (right side brain). This integration of information processing techniques

avoid the limitations of each technique while capitalizing on their unique benefits. Expert Systems, and Knowledge-Based Systems in general including artificial neural network, are computer programs that deal with complex problems ordinarily solved by human experts who are highly skilled, trained, and experienced in the specific area of interest.

The conceptual construct that provides the framework for the OP/D-based research management processes is described in three phases as shown in Table 1.

Table 1 PARTICIPATIVE R&D MANAGEMENT PROCESS

PHASE		PROCESS	MANAGEMENT LEVEL	MANAGERIAL STYLES
I				
Position Audit	a	Pre-Vision	Sr. Executives (with R-MEN)/Sr. Scientists	Authoritative
	b	Strategic Vision	Sr. Executives (with R-MEN)/Sr. Scientists	Democratic
	c	Design & Planning	Sr. Executives (with R-MEN)/Sr. Scientist	Democratic/ Authoritative
II				
R&D Process	d	Introduction	R&D Director	Authoritative
	e	Implementation	Sr. Scientists/Bench Level Investigators	Pace Setting/Coaching
III				
Control	f	Evaluation & Control	Sr. Executives (with R-MEN) Sr. Scientists	Coaching/Affiliative/ Coercive

The above steps and components are identified to facilitate the development of accurate activity standards to be used in the tracking, evaluation and control to foster accountability and productive efficiency. The general outline of the processes is in spirit with the reports of Dubnicki and Williams [1991], Englert [1991], and Kostoff [1992a]. The phases are briefly described below, see Odeyale [1993] for detail.

PHASE I

This phase includes the development of the strategic plan, which defines and communicates longer-term research directions, and the development of the operating plan, which specifically identifies the projects that will implement the strategic plan taking into consideration the goals, quantifiable objectives and development of the individual investigator and the organization. Series of processes with interlacing feed-back- and feed-forward-loops in operation during this phase include:

1. Formation of a top-management pre-vision team composing of theorists, <u>technologists</u> and practitioners who must demonstrate

interest and commitment to this process and the **RIA** program as a whole. This team must be able to explain the "whys" behind directions or decisions in terms of the employees' and/or the organization's interests. Top management must include in their considerations: a) the uncertainties of innovation and the environments; b) the recognition of technology push (the brilliant idea seeking a field/market) and field/market pull (a field/market need seeking a product), and what the general corporate climate or attitude is on projects based on either; c) the determination of attribute, and formation of attribute tables with the disciplines or sciences which are determined to be absolutely necessary in the support of R&D unique to the organization.

2. Transformation of research, and research management policies and strategies into key terms that are used later in proposal text-body content analysis. Policies and strategies may include the research direction, preferred research technology, goals, objectives, values, etc.

3. Machine learning of the policies and strategies by **R-MEN** whose method of learning is incremental concept formation. The policies and strategies are grouped by research area as they are learned. They become a form of long term memory that remains the same until a change in policy and strategy is recognized and implemented by the management.

4. Collection of contract/grant applications through a Bulletin-Board-Service-like client/server system. From anywhere in the world through a software like "PC ANYWHERE", individual investigators can call in to fill out grant application electronic forms that visually resemble their paper counterparts. In addition, the bottom of the forms and/or the last page contain(s) control buttons for the collection of prediction/assessment related data which are needed for network computing such as benefit, contribution, feasibility, need, impact value, and proposal index value calculations. This same method is used for the collection of proposal review, and evaluation/monitoring related data such as solicitation of quantifiable opinions and objectives from reviewers and individual investigator, respectively. For example, investigator-objectives are projected and quantified for each evaluation period (one year) as follows:

a) No. of Poster Presentations (0.5 point each);
b) No. of Abstract Publications (1 point each);
c) No. of Paper Publications (1.5 points each);
d) No. of Graduate Seminar Lectures (2 points for a "once-a-week-one-semester" lectures);
e) No. of Developments (2 points each);
f. No. of Patent Applications (3 points each).

As an element of vision, the top management may envision or set as objectives for the whole (private or public) organization

300 publications, 450 published abstracts, 200 postal displays at major scientific and/or engineering society meetings, 10 developments, and the assignment of at least three patent rights in a one year period. All objectives <u>must be</u> in-line with those of the organization. After the completion of the forms, with appropriate warnings, access to application forms are denied once the "SEND" button is pressed.

5. The applications are grouped by research area as they are collected. At the end of funding agency published collection period, coded policies and strategies are used in proposal text-body content analysis of each proposal. That is, **R-MEN** will search the text-body of each application for the coded key terms, counting and adding only one instance of each key term. A major concern about the use of this technique is that investigators who know the key terms may write their proposals directly to address the key terms. Ideally, that is what the administration should require, i.e., the alignment of the investigators' goals and objectives with those of the organization. Besides, the investigators must meet their projected quantified objectives if they want their projects funded the next time around. This is outcomes-management, placing greater reliance on standards and guidelines. Furthermore, such resourceful proposal writing will be revealed during feasibility, need, and benefit calculations as described below. Anyway, the result of this content analysis changes (triage) the state of the application to either exclusion or inclusion in further review process.

6. For R&D Area-Science Relationships (feasibility), Science-Requirement Relationships (need), and Requirement-Value Relationships (benefit), a portion of **R-MEN**'s inference technique uses a modified version of the Multiattribute Utility Technology (**MAUT**) in electronically obtaining the views of experts (from universities, government and industries), respectively, on: a) the potential impact of break-throughs in a research area on disciplines, and specific research subject; b) the contribution of the Science to satisfying operational requirements through suggested research opportunities (proposals); and c) the magnitude of the contribution of a set of proposals to satisfy a set of needs. Refer to Edwards [1980, 1982] for detail on **MAUT**. When a reviewer calls in to contribute his/her opinion to the opinion table, he/she will be asked to: i) review provided list of value disciplines and areas of interest in the terms of their being affected by any research break-through in one of the areas of interest (say blood substitutes); ii) rank order the value disciplines and provided areas of interest to reflect their being affected by research break-through in blood substitutes; and iii) weigh the value disciplines - assign 10 points to the least affected disciplines, then accordingly assign the relative impact of blood substitutes research break-through on each discipline, (the limit is 100 and as many as 100, 500, etc. experts can "review" a proposal).

7. Before final proposal review and indexing, a mean for hypothesis testing is provided. This nonprimitive function provides relationship Congruency or Entropy values ranging between zero and a system determined value, depending on the data provided. It provides a choice of 99, 95, 90, 75 or 50% confidence level for the calculation of the entropy value. A value of zero means that the newly generated information/knowledge from **MAUT** obtained data adds relatively no useable information/knowledge to the existing one. A break-through research in a project may insignificantly contribute to a limited number of disciplines, i.e., there is no cross-fertilization. Replacing the entry in the cell of interest with a new value and repeating the calculation will generate a new value which may or may not be acceptable. Thus, it assists in the identification of special problems to be addressed before project selection. On the other hand, a value other than zero indicates a level of added useable information/ knowledge to the existing one. A break-through research in a project may significantly contribute to a number of disciplines, i.e., there is cross-fertilization.

8. Impact and index values are calculated for each of the applications using data including investigator's performance record, stated objectives, and desired outcomes. Every application whose "CRITERIA MATCH" field is occupied is included in the organization's R&D portfolio and automatically indexed based impact and index values. If they have not already been entered, the system will ask for available resources and minimum reserve, then, it will start assigning fund to projects starting from the one with the highest index value until the minimum reserve is reached.

PHASE II

This phase represents the necessary education, and management support needed to prepare the staff to participate in such an "Action Research" effort. This phase identifies and utilizes the critical components required to develop an environment that facilitates participative research management activities. A significant activity occurring during this phase is daily verification of individual scheduled training and development. If an individual has no recorded training and/or development within a preset period, the system will generate and send a report through E-mail directly to the office of the director for R&D. The system will be able to look at a training and/or development description(s) and compare it/them with the background of the individual to determine if the training and/or development is/are suitable for that individual. This is one of the ways how **R-MEN** shows concern for human feelings and human needs for support, dignity, and fulfillment in work.

PHASE III

This phase represents a means by which participative methods can be put into operation in developing productivity tracking systems. Significant activities occurring during this phase include project evaluation and control. This entails periodic

monitoring of project milestones for applied research, and research objectives for the more basic research. If a project has no recorded fulfillment of a milestone within a preset period, the system will generate and send a report through E-mail directly to the office of the director for R&D.

ANTICIPATED BENEFITS

Frequently in human affairs, past intellectual baggage hinders our ability to forge novel approaches. Therefore, we advocate the use of **R-MEN** concurrently with present research review process. During this period, **R-MEN** is foreseen as a supplement in the form of a guide to data generation, acquisition and processing, and a validity check. Before long, just as the **R-MEN**'s anticipated review period is very significantly (62.5 - 66.67%) less than that required by un-aided review, other **R-MEN** benefits, including those presented below, will standout as well.

With appropriate implementation and maintenance, this knowledge technology, which utilizes demonstrated and proven approaches, methods, procedures and techniques in an innovative and unique way, would:

1. Provide a means for **effective**, policy- and strategy-oriented management through outcomes-management.
2. Improve management quality, reduce operation costs, and increase productivity and public trust.
3. Foster impact evaluation to document Federally funded program and management effectiveness.
4. Provide short-term (three-year) program progress tracking and long-term (ten-year) result(s) impact tracking.
5. Shield administrators, managers, and other policy-makers from the complexity of the mathematics of the inference machine.
6. Permit the evaluation of a range of alternatives.
7. Permit handling large amounts of data.
8. Permit policy-makers to have a better understanding of existing technical attributes of and capabilities for potential projects.
9. Facilitate choice of strategy compatible with agency structure and processes, and with the policy or the nature of decision making for activities scheduling and control.

According to Nonaka [1991], "In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge. And yet ... few managers grasp the nature of the knowledge-creating company - let alone how to manage it. The reason: They misunderstand what knowledge is and what companies must do to exploit it."

Is the reader up to date in strategic information/knowledge technology application? Is his strategy-structure and/or reward and training systems barriers or opportunities to professional and organizational success? Does the reader know how to integrate information technology with your research management processes? These are where the authors' **R-MEN** technology comes in.

QUANTITATIVE METHODS - SUMMARY AND CONCLUSIONS

To summarize the quantitative methods section, few Federal agencies report use of bibliometrics to evaluate programs and influence research planning in the published literature. Cost-benefit and other economic approaches have been reported in the published literature over the years. The foundation on which these approaches rest needs to be strengthened to improve their credibility. As Averch [1991] states, after describing the huge social rates of return to investments in hybrid corn reported by Griliches [1958]: "In general, economists compute high social rates-of-return to most kinds of research. The rates, in fact, are usually much higher than those computed for other kinds of public investment. So there is a puzzle as to why research investments do not increase until their marginal return just equals returns from other public investments."

IV-C-1. APPLICATION OF METRICS TO RESEARCH UNDER GPRA

The federal government is the largest single sponsor of fundamental science research today. Increased scrutiny of federal programs in the drive toward deficit reduction requires increased public accountability for the stewards of the government's research funds. The Government Performance and Results Act (GPRA) of 1993 [Public Law 103-62] was passed to improve the accountability of government funded programs by measurements of performance against planned targets. Federal agencies are required to initiate implementation of GPRA in FY1997; pilot projects [Brown, 1996] will help identify performance measures for different types of programs. However, it is extremely important that the tools used to enforce research accountability do not destroy basic research.

There are three major components to GPRA: Strategic plans, annual performance plans, and metrics to show how well the annual plans are being met. Classical strategic planning derives from the military and commercial world, focuses on the application of knowledge toward a pre-defined goal rather than the search for knowledge, and assumes that the links between plans and targets are understood.

Annual performance plans are derived from production and service industries, where efficiency in the use of known resources to achieve well defined targets over the performance period is the main goal. Revolutionary basic research, which has yielded some of the largest downstream payoffs historically, has an inherently large uncertainty and failure rate, and may take many years before results are forthcoming. This intrinsic long-time scale characteristic of basic research conflicts with the short-term emphasis of much of the corporate world, where annual reports and requirements for quarterly financial performance shorten the production period for research results. This near-term focus on financial performance has essentially eliminated long-range high-risk fundamental research financed from corporate funds in most industries.

Metrics that gauge adherence to annual performance plans derive, in modern times, from the time and motion study component of industrial engineering. Again, these tools measure efficiency of the use of known resources to achieve specific goals over a set time period. At present, such output metrics are applied informally to research for purposes of academic analysis (3), and these analytical results may provide useful insights to research activity. Annual application of these quantitative indicators is more appropriate for measuring the short-term observable outputs that characterize activity and productivity (cars produced, papers published) than the long-term outcomes that characterize mission and societal impact (improving health, enhancing safety). A major concern of researchers is that the short-term services and production orientation of the GPRA planning and metrics components could re-focus the research away from long-range high-risk revolutionary science challenges to shorter-term low-risk evolutionary product-oriented goals. Annual application of these metrics to basic research in the formal bureaucratic sense of GPRA could convert the nature of the research being conducted from a quest for knowledge and understanding to a drive for output metrics. Uncertainties inherent in basic research bring into question the validity and credibility of any long range plans to achieve specific goals, since long-term research effectiveness and impact will depend on economic, environmental, and geopolitical factors not evident during the research phase.

A more subtle concern is that application of the present GPRA approach to basic research may effectively yield the same results as government imposed censorship. The requirements of federal agencies to display compliance with the GPRA metrics may reorient their selection of research proposals to maximize these arbitrary measures. Concepts that could improve understanding and the unification of science, but would not optimally satisfy the GPRA metrics, might no longer be proposed for federal funding because of lower funding probability. (The author is reminded of Solzhenetzyn's views that the worst part of documents being censored was not that sections were rejected; the worst part was the loss of those ideas which were not even expressed and eventually no longer considered because of the knowledge that they would be censored). Safe, short-term, low-risk evolutionary research would become the accepted practice. Basic research needs to be decoupled from 'strategic' targets and GPRA metrics, and the scientific roadblocks and challenges alone should be the stimuli for research activity.

A more appropriate accountability approach for basic research is: i) articulation of a rational investment strategy; ii) long and short-term retrospective studies that show the diverse benefits from past research and potential future benefits; iii) quality control of expert peer review. An organization's research investment strategy is a rationale for the prioritization and allocation of resources to address knowledge deficiencies which impede attainment of the organization's goals. Short-term retrospective studies show how recent research has affected fields

of science, and may contain projections of future impacts of research on technologies, systems, and operations. Long-term retrospective studies of major innovations and outcomes in systems and technology show the origins of critical research and development advances in a broad spectrum of fundamental research performed many decades earlier. Expert peer review on a periodic basis will validate the soundness of the investment strategy and the importance of the research accomplishments and subsequent technology impacts.

Peer review properly designed to support GPRA would provide credible indication to the research sponsors of intrinsic program quality, program relevance, management quality, and appropriateness of direction, and has the potential to improve the quality of the research program as well. Before such a review process is implemented, a number of considerations have to be addressed, and they have been described in detail in the previous section on peer review.

In summary, peer review is the appropriate central evaluation mechanism for basic research under GPRA, but careful thought and planning will be required to implement a viable and credible peer review process.

IV-C-2. CITATION ANALYSIS CROSS-FIELD NORMALIZATION: A NEW PARADIGM

CROSS-FIELD CITATION NORMALIZATION: THE ISSUES

Science, Nature, Physics Today, Scientometrics, and other leading science and science evaluation journals continually publish articles comparing and ranking technical disciplines, departments, institutions, countries, and people on the basis of literature citations. Because of differences in numbers of researchers in different fields and in citing cultures, normalizations of absolute citation numbers to some reference are required to assign meaning to any comparisons. As shown in a recent review of cross-field citation normalization techniques, all present methods normalize citations of a given paper to citations of similar theme papers [Schubert, 1993]]. The two main differences among these methods are how the similar theme papers are defined (e.g., papers published in same journal issue, papers sharing a threshold number of common references, etc.), and what types of mathematical/ statistical approaches are used to normalize the position of a target paper relative to that of its competitors. This limited comparative approach allows relative comparisons among similar papers, but ignores two crucial points. Purely relative comparison with other similar papers does not allow very credible comparisons among different disciplines based on citation analysis, and does notprovide an indication of citation efficiency.

To gain wider acceptance and credibility, citation analysis needs to overcome these two limitations, and offer the broader perspective of how frequently a paper was cited compared to how frequently it could have been cited. The following sections

describe a citation normalization method that would overcome the above two limitations, and provide the added dimension offered by the broader perspective.

CROSS-FIELD CITATION NORMALIZATION: A NEW PARADIGM

The fundamental concept of the new paradigm was derived from the thermodynamic principle of Carnot efficiency. The thermodynamic analog will be described through an illustrative example, and the metamorphisis to citation efficiency will then be shown.

Assume that two classes of engines are being evaluated. One class of engines (hereafter called fusion engines) has been developed to convert energy being produced in very high temperature fusion reactors, and the other class (hereafter called ocean engines) has been developed to convert energy from the temperature differentials in the deep ocean. Assume that there are three different fusion engines being evaluated in the fusion class, and the demonstrated conversion efficiencies of these engines are 1, 2, and 3 percent, respectively. Assume that there are three different ocean engines being evaluated in the ocean class, and the demonstrated conversion efficiencies of these engines are also 1, 2, and 3 percent, respectively.

If it were desired to evaluate the performance quality of all six engines, with efficiency being the metric of quality, one simplistic approach would be to rank all six engines by demonstrated efficiency. The fusion engines would, on average, have equivalent quality to the ocean engines by this approach. However, a far better indicator of performance quality would be the ratio of each engine's demonstrated efficiency to the maximum efficiency the engine could achieve in its operating environment.

From thermodynamics, this maximum theoretical efficiency that each engine could achieve is the Carnot efficiency, which is a function of the high temperature and low temperature extremes in which the engine operates. For very high maximum temperatures and near-ambient low temperatures (characteristic of fusion), the Carnot efficiency approaches unity, and for low maximum temperatures and ambient low temperatures (characteristic of ocean), the Carnot efficiency approaches zero. If the comparison figure of merit becomes the ratio of demonstrated efficiency to Carnot efficiency, then the ocean engines in this case would outperform the fusion engines by a wide margin, since the ocean engines are operating closer to their theoretical maximum than are the fusion engines. Even where the engine evaluation is limited to one field (e.g., fusion), viewing relative performance from the new efficiency ratio perspective provides an added dimension for understanding performance, while the relative engine rankings within fusion remain unchanged.

Now the crossover from thermodynamic efficiencies to citation efficiencies will be made, with use of analogs to the above example. For fusion, convert each engine into a research paper of similar theme, and convert each engine efficiency into citations

received by the research paper over some unit of time. Thus, there are now three fusion research papers of similar theme being compared which have 1, 2, and 3 citations over some unit of time, respectively. Similarly, for ocean, there are now three ocean papers of similar theme being compared which have 1, 2, and 3 citations over the same unit of time, respectively.

Generically, the existing orthodox approach to cross-field citation normalization might divide the number of fusion citations by the domain average (2.0) and provide each fusion paper a normalized value and ranking in its class. Thus, the paper with 3 citations might have a normalized value of 1.5 (3/ 2), and an upper 33 percentile ranking. Using similar normalization for the ocean papers and dividing citations by 2.0 (the domain average), the paper with 3 citations might have a normalized value of 1.5 (3/ 2), and an upper 33 percentile rating. The existing orthodox approach would consider the leading paper in each class as the same quality because of identical ranking in its class (upper 33 percentile). However, as in the Carnot cycle analogy, a better figure of merit for quality would be the ratio of actual number of citations received by a paper to the theoretical maximum number of citations that could be received by the paper, a quantity which will be termed the citation efficiency. Then, different papers in the same field, as well as papers in different fields, could be compared on the basis of citation efficiency. The citation efficiency becomes the cross-field normalizer, and indicates how well a paper performed from a citation perspective compared to how well it could have performed. It is an intrinsic measure of accomplishment.

DETERMINATION OF CITATION EFFICIENCY

There are two crucial steps involved in determining the citation efficiency, and they are not completely independent. To compare a target paper to other papers, the first step is the selection of the universe of papers to be compared and the second step is the determination of the maximum number of citing papers to be used in the computation of efficiency. For present purposes, assume that a universe of papers to be compared to the target paper has been selected using existing techniques. Again, for present purposes, assume that this universe consists of sub-universes of papers with similar themes. Thus, the universe of fusion and ocean papers consists of a fusion sub-universe with similar themes and an ocean sub-universe with similar themes.

Next comes the determination of the maximum number of potential citing papers. The following theme-centered approach is proposed for computing maximum potential citations. For the fusion papers within the similar theme sub-universe, the maximum number of times one of the fusion papers could have been cited (in the given unit of time) is assumed to be equal to the number of different citing papers in which any of the papers in the fusion sub-universe were cited. Any of these citing papers could have cited 0, 1, or all of the similar theme fusion sub-universe papers. The same procedure for determining the maximum applies to the ocean papers,

but the fusion maximum will probably be quite different from the ocean maximum. Then the citation efficiency of each paper in the selected universe can be computed, and the papers compared by this figure of merit. The actual number of citations of each fusion paper would be divided by the fusion paper maximum (this maximum is the same for all the fusion sub-universe papers) to arrive at the efficiency, and the actual number of citations of each ocean paper would be divided by the ocean paper maximum (this maximum is the same for all ocean sub-universe papers) to arrive at the efficiency.

The following figures illustrate how such an efficiency computation would be performed. Figure 1 is a matrix showing how many times each citing paper (A, B, C) cites each cited paper (G, H, I) for the ocean case.

FIGURE 1 - CITING PAPER VS CITED PAPER MATRIX: OCEAN

```
..............CITING PAPER
................A..B..C
............G...x..x..x
CITED.......H...x..x
PAPER.......I...x.
```

The x(s) in the matrix represent a citation. Thus, citing paper A cites papers G, H, and I, while citing paper C cites only paper G. The maximum number of potential citations for papers G, H, or I is 3, because there are three citing papers. The citation efficiency of G is 1 (3/ 3); the efficiency of H is .67 (2/ 3); and the efficiency of I is .33 (1/ 3).

Figure 2 is the same type of matrix for the fusion papers. The citing pattern has been changed.

FIGURE 2 - CITING PAPER VS CITED PAPER MATRIX: FUSION

```
..................CITING PAPER

................A'.B'.C'.D'.E'.F'

...........G'...x..x..x..
CITED......H'............x..x
PAPER......I'..................x
```

Now, each citing paper (A'-->F') cites only one of the fusion papers (G'-I'). The maximum number of potential citations for papers G', H', or I' is 6, because now there are six citing papers. The citation efficiency of G' is .5 (3/ 6); the efficiency of H' is .33 (2/ 6); the efficiency of I' is .17 (1/ 6).

Under the present normalization system, paper G would have been rated as the same quality as paper G', since each ranked first in its own thematic sub-universe, and paper I would have been rated as the same quality as paper I', since each ranked last in its own thematic sub-universe. Under the new system proposed here, paper G

ranks above paper G', and paper I ranks above paper I'. This is displayed more graphically in Figure 3, where the citation efficiencies of the ocean papers are obviously higher than their fusion counterparts.

```
FIGURE 3 - CITATION EFFICIENCY VS NUMBER OF CITATIONS
...........OCEAN VS FUSION

..............1.*...............Gx
................*
................*
................*..........Hx
CITATION........*
.............0.5*.................yG'
EFFICIENCY......*
................*....Ix.....yH'
................*.....yI'
................*
..............0.*.....*.....*.....*....
................0.....1.....2.....3
................NUMBER.OF.CITATIONS.
```

Aggregate citation efficiencies may also be defined. Assume the aggregate citation efficiency of the group of ocean papers (G, H, I from figure 1) were desired. This quantity is the ratio of the number of citations received by papers G, H, and I (the number of asterisks in figure 1) to the maximum number of times these papers could have been cited (the nuumber of matrix elements in figure 1). For the figure 1 example, this aggregate citation efficiency is .67 (6/ 9), and for figure 2 this aggregate citation efficiency is .33 (6/ 18).

This example illustrates the added dimension provided by the citation efficiency perspective; the ability to evaluate and interpret research paper utilization patterns within and across different disciplines. Is the difference in aggregate efficiencies due to a different level of awareness of ocean and fusion authors of the intellectual foundations of their respective fields, and/ or is the difference due to the different levels of quality and uniqueness of the intellectual foundation papers in the different fields, and therefore different citation desireability of these papers? What other factors are operable [2, 3]?

Finally, the 'quality' of different citing journals (or any other quantified parameters associated with each journal) may be incorporated in the citation efficiency by computing a quality-weighted citation efficiency, or a quality-weighted aggregate citation efficiency.

SUMMARY

A new paradigm for comparing quality of published papers across different disciplines has been proposed. This method uses

a figure of merit of the ratio of actual citations received to the potential maximum number of citations that could have been received. It is analogous to approaches used to compare performance in physical systems, and appears intrinsically more useful than present approaches.

IV-C-3. THE PIED PIPER EFFECT: A SPECIFIC EXAMPLE

An article in Science magazine purports to identify the Top 10 U.S. Universities in Clinical Medical Research from 1990-1994 [SCIENCE, 1995]. The published papers and citations per paper are ranked in decreasing frequency by medical research institution, and the institutions with the highest frequencies of publications and citations are identified as the top universities in clinical medicine research. This Science article crystallizes the problem of using metrics as a gauge of research productivity and, by inference, quality. This statement will be amplified with an illustrative example which questions the linkage between high research output and high research quality. The example focuses on cataracts, but is extrapolateable to other chronic systemic problems as well.

The author recently did a literature survey of research papers related to cataracts. The author examined four years (1991-1994) of abstracts from the Science Citation Index (SCI) and the Social Science Citation Index (SSCI). Of the many hundreds of abstracts identified, perhaps 99% dealt with different aspects of the surgical treatment of cataracts. Maybe 1% or less dealt with nutritional approaches, and these were mainly vitamin and mineral supplementation for prevention. There were no papers in these peer-reviewed journals dealing with alternative approaches to cataract treatment.

The mainstream medical community views cataracts strictly as an eye problem. The lens degenerates for unknown reasons, in their view, and when it has deteriorated sufficiently, it should be replaced surgically.

An alternative paradigm is that the body experiences chronic systemic problems (deficiencies of various types), and these problems manifest themselves as symptoms in specific organs. For some people, the weak organ is the eye, and the symptom is the cataract. Healing, in this paradigm, consists of identifying and eliminating the deficiencies. Surgically removing the cataract, while improving functioning (at least temporarily), does nothing to address the fundamental systemic problems which are at the foundation of the cataract's presence. It is equivalent to removing the warning light on a car's dashboard when it signifies a problem.

These alternative approaches never surface in the peer reviewed literature, as the author's survey has shown. The journal reviewers (and the funding proposal reviewers as well) are researchers trained along the orthodox paradigms, and they provide high marks to those papers (and proposals) aligned with the reviewers' backgrounds. In addition, there are institutional and

commercial biases which also govern the willingness of the reviewers and editors (and sponsors) to provide positive evaluations of alternative approaches. Thus, the copious papers and citations (and grants) from this component of medical research reflect activity among a closed group whose members subscribe to essentially the same orthodox paradigm. Far from being a measure of quality, the numbers of papers and citations (and projects) from some branches of medical research could be interpreted as a measure of the extent of the problem.

Near the beginning of section VII (and scattered throughout this Handbook as well), the author differentiates between the two major characteristics of high quality science: doing the job right and doing the right job (in the best of all worlds the right job right would be done). The Science article is an example of doing the job right. Once the research target has been selected (paradigm of using the surgical approach to eliminating cataracts), the orthodox medical research community performs an excellent and highly productive effort in finding the best ways to achieve the target. It is analogous to firing a missile very accurately at the wrong target. However, one can question seriously whether they are doing the right job (using the right paradigm), and the present closed funding, review, and publication structure effectively precludes innovations which will address the right job.

The Science article, and the above comments, illustrate the danger of relying on metrics to infer quality from scientific activity. Metrics have their place in a comprehensive evaluation procedure of research as the previous section has shown, but as a stand-alone approach as reflected in the Science article metrics are subject to misinterpretation.

V. RECOMMENDED AREAS FOR RESEARCH IN RIA

V-A. Semi-Quantitative Methods

The Hindsight, TRACES, and ARPA studies provided valuable insight into the parameters which affect the quality and productivity of research. These types of studies should be expanded. More organizations, such as in the ARPA study, should be examined from a retrospective viewpoint. More technologies and systems, as in the TRACES and Hindsight studies, should be examined. However, more emphasis should be expended on identifying and tracing the pathways of the indirect impacts of research. Especially for basic research, the research products are disseminated broadly, impacting eventually not only the sponsoring organization's goals, but the broader societal goals as well. These broader impacts should be captured within the studies.

The latest technologies, such as information processing and computer hardware and software, should be employed in these retrospective approaches. As suggested previously, in the section describing the recent TRACES study [Narin, 1989], citation and co-citation analysis, combined with co-word analysis, could trace some of the indirect impact pathways. Citations of successive generations of papers, for example, could document the diffusion

and dissemination of the products of research.

Alternatively, network approaches could explore the information flow among research and technology areas. Combined with co-nomination techniques, these approaches could not only shed light on information dissemination, but on the people involved in the diffusion process as well. Since these bibliometric, network, and co-occurrence approaches were presented in the text as examples of quantitative techniques, but are listed now under proposed semi-quantitative studies, they will not be repeated later in the section on proposed quantitative studies. In the present context of being combined with the retrospective approaches, they become hybrid approaches (quantitative/ semi-quantitative).

Central to credible work in tracking the diffusion of information from research is a database of research products at various evolutionary stages which can feed the models. Since the research product evolutionary pathways transcend the research originating organization, and can intersect all societal sectors, the cooperation of many public and private organizations would be required to develop a database of research products in their evolutionary stages. Development and construction of such a database should start now.

V-B. <u>Peer Review</u>

One of the central problems in peer review is lack of credibility in its predictive reliability. More studies are necessary to relate evaluations by peers of research proposals and existing research programs to future impacts of this research. Presently, the data to validate different predictive models does not exist. As stated above and reiterated in section V-D, what is required is a database which allows tracking of the evolution of products of research in their various metamorphisized stages. Having such a database would allow not only validation of peer review predictive models, but bibliometric predictive models and other quantitative predictive models as well. The database would allow predictive reliability to be determined for a number of different types of impact. These would include impact on the research area of interest, impact on allied research areas, impact on technology, impact on systems, impact on operations, etc.

An excellent discussion of the validity and reliability of the peer review results can be found in Cicchetti [1991], as well as in other commentary in the journal issue in which Cicchetti's article appears. To improve validity and reliability, research needs to be done on optimal numbers of reviewers utilized; ascertaining whether author anonymity impacts the results; and ascertaining whether training people to perform peer reviews would increase review quality as well as reliability and validity.

There are very few comparative studies of different types of peer groupings and the quality of the peer review product. Studies should be done varying mail vs. panel review, British model vs. standard model (peer review using professionals instead of eminent persons), panel size, types of reviewer expertise, time expended by the reviewers and reviewees on the process, and correlating these

variables with the quality of the product. Central to the result would be how cost of the review varies with quality of the product and is affected by the different variables.

While the present Handbook included a very approximate estimation of total peer review time and dollar costs for one peer review scenario, more accurate time and cost estimates would be required when comparing different types of peer review scenarios. Extensive data taking would be necessary, because of the many different types of peer reviews in existence. However, since total peer review costs can be substantial, and since cost reduction with consistent quality would be one of the goals of these different types of suggested studies, both the extensive data taking and development of improved peer review cost estimating procedures would be well justified from an economic viewpoint.

The application of expert systems and knowledge-based systems for proposal evaluation and program review could supplement peer review. Few studies have been done along these lines, but a recent dissertation [Odeyale, 1993] and follow-on studies [Odeyale and Kostoff, 1994a, 1994b] address this problem in detail . Much more work would be required to validate the application of these advanced technologies as useful supplements to peer review, but more research in this direction could determine whether there is potential for real payoff.

One of the potential benefits resulting from a peer review is constructive feedback to the reviewee(s) followed by an improvement in the reviewee's conduct of research. Studies should be done to ascertain reviewees' perceptions of the peer review and the review's value in improving the conduct of research. A recent study [Luukkonen, 1993] addresses peer review from the reviewee's perspective, but much more can be done to improve the information transfer from the reviewers to the reviewee, and to insure that the review's recommendations were translated into improved research.

Finally, there are non-tangible aspects of peer reviews on which research could provide valuable information. For example, in many periodically scheduled reviews, relatively few programs receive poor grades. This leads to the critique that the reviews are not cost-effective; too much time and effort are being expended for too little return. The rationale supporting the reviews is that the knowledge that the review will occur maintains a high threshold of research quality. Performers will be less inclined to work on their theses for decades if they know that they will be evaluated periodically. The analogy is to a well-known speed trap on a highway. The knowledge that a stretch of road is well policed is sufficient to keep the average speed within the posted limit. The fact that the officers write relatively few tickets in this area is not a measure of effectiveness of the speed trap. Studies should be done comparing the quality of research of periodically reviewed programs to infrequently ad hoc reviewed programs to see if this supporting rationale is in fact valid.

On the other side of the spectrum, would the knowledge of periodically scheduled reviews stifle the pursuit and presentation of very innovative but far-out ideas. Would performers be

reluctant to present these ideas in a public forum, where the credibility of the performers could be challenged for these ideas. Research is needed to ascertain whether ideas have been suppressed in periodically reviewed programs, and to determine how this problem could be surmounted.

V-C. <u>Quantitative Methods</u>

In the practical use of bibliometrics, one of the problems which arises is cross-discipline comparisons of outputs. For example, how should the paper or citation output of a program in Solid-State Physics be compared to that of Shallow Water Acoustics. What types of normalizations are required to allow comparisons among these different types of programs and fields. Is there a threshold for disaggregation below which the normalization factors apply to all the subfields. For example, can the normalization factor for Acoustics be applied to a program in High Frequency Shallow Water Acoustics, or can the normalization factor for Shallow Water Acoustics be applied to the program in High Frequency Shallow Water Acoustics?

Or, is credible normalization not possible? A recent survey of important research performance indicators [Australia, 1993] was described in the bibliometrics section of the present Handbook. The survey results indicated that the important performance indicators may rank differently for different disciplines. This suggests that multiple indicators would be required for any cross-field comparisons. Under these circumstances, cross-discipline comparisons would require not only normalizations for the same indicators, but some type of weighting correction to account for the different relative importance of the indicators on different disciplines. More research on these issues needs to be done to make cross-discipline comparisons using bibliometrics more acceptable.

An area of bibliometrics which has been gaining in popularity over the past decade has been that of partial/multiple indicators [e.g., Martin, 1983; Rubenstein, 1988, 1991]. In some applications, different partial indicators are combined to give an overall figure of merit. A number of research issues need to be addressed here. If the indicators do not form an orthogonal set, there will be multiple counting, and the results will be skewed. As a hypothetical example, if it were shown that publications were strongly correlated with awards, then including publications and awards in the figure of merit would be a double counting of publications. There needs to be research showing how the different leading indicators are related to each other, whether the relationship varies for different disciplines, and the degree to which the different indicators overlap.

Typically, the indicators are combined in a linear manner to arrive at the figure of merit. In addition to the problem that the weighting factors may be field-dependent, as discussed in the section on cross-discipline comparison above, the linear assumption may be invalid over the full range of the indicators. For example, marginal utility theory would suggest that while it might be twice

as valuable for a researcher to publish two papers per year compared to one paper, it would probably not be twice as valuable if the researcher were to publish 40 papers per year as opposed to 20. It certainly would not be 40 times as valuable if the researcher were to publish 40 papers per year as opposed to one paper per year. Research needs to be done to identify the utility functions for these indicators, and identify the regions where the linear assumption is valid.

One rapidly emerging area, for which substantial databases are in existence, is patent citation analyses. Yet there has been negligible use of this capability by the Federal government for research impact assessment, and assessment of the conversion of science to technology. Studies should be done to ascertain the regions of validity of patent citation analysis, and the constraints and limitations of the technique. For those technologies and research disciplines where the technique has validity, studies should be done using patent citation analysis to track the diffusion of research information. Perhaps the technique could be used in tandem with the other citation approaches in supplementing the retrospective approaches suggested in the section on proposed semi-quantitative studies. It would be valuable to understand the parameters which influence the successful conversion of science to technology.

A number of specific studies are suggested for large multi-spectrum Federally-supported laboratories, to ascertain whether these organizations are making effective and efficient use of their multi-discipline capabilities:

1. Examine distribution of disciplines in co-authored papers, to see whether the multidisciplinary strengths of the lab are being utilized fully;
2. Examine distribution of organizations in co-authored papers, to determine the extent of lab collaboration with universities/ industry/ other labs and countries;
3. Examine nature (basic/ applied) of citing journals and other media (patents), to ascertain whether lab's products are reaching the intended customer(s);
4. Determine whether the lab has its share of high impact (heavily cited) papers and patents, viewed by some analysts as a requirement for technical leadership;
5. Determine which countries are citing the lab's papers and patents, to see whether there is foreign exploitation of technology and in which disciplines;
6. Identify papers and patents cited by the lab's papers and patents, to ascertain degree of lab's exploitation of foreign and other domestic technology;
7. Compare the lab's output (papers/ citations normalized over disciplines) with that of other similar institutions, taking into account the concerns above on cross-discipline normalization.

The production function approach described in the text [Averch, 1987, 1989] essentially regresses desirable research

outputs (citations per dollar, etc.) against research inputs (quality of the investigator's department, etc.). One potential application is prediction of high output proposals based on prior knowledge of the investigator and proposal characteristics (the research inputs). This could be a useful supplement for proposal peer reviews, especially in those cases where quality differences among different proposals are not large, and use of prior knowledge could impact the outcome. Studies should be done to:

1. identify the appropriate output measures;
2. identify the appropriate input measures;
3. estimate the production functions for different disciplines;
4. provide some understanding of the predictive reliability of the approach.

For agencies which sponsor some accelerated research programs, or which have the charter of funding accelerated research programs to hasten transitions, marginal cost-benefit studies of the type used by Mansfield [1991] should be made to study the research impacts. Applications of these approaches to the early stages of basic research should be evaluated, such that the indirect impacts of basic research are given appropriate credit in an economic sense.

For mapping the structures of different fields of science and technology, comparative studies should be done of co-word, co-citation, and co-nomination approaches, and hybrid combinations of these co-occurrence techniques. There should be synergistic benefits from the hybrid approaches, since different complementary data are used in each approach.

For the full-text co-word analysis, automated data analysis and interpretation techniques should be developed to reduce the labor intensity of the process. The full-text technique should be applied to technical journals to identify emerging research and technology areas, as well as the evolving structure of the technical discipline. For example, with present desktop computer memory capabilities, full-text co-word analysis could be applied to one or more year's issues of the Journal of the American Chemical Society to identify the emerging research areas in Chemistry, and to provide some understanding of the inter-relationships among the different areas in Chemistry (and perhaps among Chemistry and other discipline areas as well).

V-D. Database Infrastructure Development

Research is the pursuit and production of knowledge. Underpinning research is the generation, flow, synthesis, and interpretation of information. Central to the assessment of research is the capability to handle all phases of the information creation, flow, and integration cycle. The explosion of available information in the last decade requires the utilization of large databases to handle this information in support of RIA.

In particular, sophisticated data collection, analysis, and

interpretation schemes can track the dissemination of information flowing from research to other applications. A credible research product tracking scheme can help identify the indirect impacts of research more precisely, and can improve correlations between research evaluation predictions (such as peer review and bibliometrics) and downstream impacts.

Comprehensive databases describing sponsored research and development programs in many funding agencies and organizations, with sophisticated software to provide rapid access to the database contents, can help improve the selection, management, and evaluation of research programs. Research gaps can be identified, duplication of programs can be minimized, complementary and joint programs can be established, substantial leveraging of other agency programs can be implemented, and technology planning can be improved with better awareness of maturing research programs.

Tailored databases which contain information about the structural relationships among projects and programs can help identify critical paths for development in R&D programs. This is important in allocating resources among programs in mission-oriented agencies and other organizations.

Sophisticated algorithms for manipulating and interpreting large technical textual databases would allow pervasive themes of the databases to be identified, as well as the relationships among the themes and sub-themes. Low frequency anomolous relationships which could be important are identified easily with these techniques. The algorithms would also allow identification of the translations between research areas and technology areas in the databases, and would provide guidelines and roadmaps for increasing the efficiency of searching unfamiliar databases.

These algorithms, and subsequent analyses, have the potential of identifying emerging research and development areas contained within the databases but not readily discernable. The software can also help in taxonomy construction, with the taxonomy elements obtained 'bottom-up' from the database language, rather than top down using an authoritative directed approach. Many different types of taxonomies could be constructed from the full text database, and relationships among the different elements of the different taxonomies could be obtained. Finally, by looking at the changes in the structure of research fields over time, the impact of sponsoring organization intervention can be ascertained.

To fully understand a research program, especially in the assessment of that program, evaluators must be cognizant of the large body of research being conducted throughout the world. In addition, to fully understand the impacts of research on different technologies, evaluators must be cognizant of the large body of existing and developmental technology throughout the world, and the existing and potential shortcomings in those technologies.

With the advent of high speed and high storage capacity computers, and advances in database software packages, the capability exists now to make large amounts of information available to researchers and evaluators. In particular, the capability exists to provide information about funded research and technology development

programs being conducted throughout the world, as well as information about existing technologies.

Subsets of this type of database do exist, such as the Federal multiagency funded research programs database developed by the author. This multiagency database was developed to identify research gaps in the larger community; to guard against potential duplication with other organizations; to identify potential complementary/joint programs with other organizations; to identify other agency programs with potential for leveraging; and to identify projected maturing research products which can be utilized for technology planning.

The multiagency database provides narrative and programmatic information about research programs sponsored by many different agencies. These agencies include the Department of Defense (Army, Navy, Air Force, BMDO, Independent R&D-funded from defense contractor overhead), and non-DOD Federal agencies (NIH, NSF, DOE, NASA, small business innovative research, etc.). Most of the narrative descriptions are at the Work Unit (principal investigator) level, but some narrative descriptions (principally, for the armed services agencies) are at the program level (where a program is a group of principal investigators). For applications where linkages between work units are important, program level narratives are more appropriate. The database presently resides on a desktop computer hard disk, but could be accessed directly from the data sources via Internet if appropriate drones and system architectures were installed. This latter architecture would allow the data which the user sees to be more current.

Two major types of studies have been performed with this database. The first is standard text retrieval searches to identify programs of interest, usually in categories defined by the end user. The second type of study (Database Tomography) involves computational linguistics techniques to extract information about the total database structure. These techniques include multiword phrase frequency analyses for identifying pervasive research thrust areas, and multiword phrase proximity analyses for identifying relationships among thematic research areas. These computational linguistics techniques were described further in previous sections.

This database has been of immense help in assessing research programs, as well as helping to plan research programs. **However, a much larger and more comprehensive database, covering not only research but technology as described above, would be of substantial benefit to the research and technology performer community, the research and technology evaluation community, and the research and technology user community.** Such a database would involve the cooperation of many government agencies, and a number of industrial organizations as well. The requirements of, and planning for, such a database should be started in the near future.

The author's multiagency database has been in existence for about four years, and his proposals for an expanded database as described above have been promulgated for almost that length of time. Recently, a major step towards this multiagency database goal has been taken. The Rand Corp. Critical Technologies Institute has developed a multiagency R&D database called RADIUS. It provides

programmatic descriptions for 21 federal agencies at five different levels of resolution.

As stated in sections V-A and V-B, central to credible work in predicting and tracking the diffusion of information from research is a database of research products at various evolutionary stages which can feed the predictive models. This database of research products could be linked in part with the above-proposed database of research and technology. Since the research product evolutionary pathways transcend the research originating organization, and can intersect all societal sectors, the cooperation of many public and private organizations would be required to develop a database of research products in their evolutionary stages. Development and construction of such a database should start now.

V-E. General

This section discusses research required for RIA which transcends any particular technique. The issues addressed are those which have hindered the acceptability of the RIA product for decades.

The first issue addressed, certification of RIA managers, is as much an education and training issue as a research issue. Successful resolution of this issue would, in the author's estimation, result in a major advance in the profession of RIA. In the author's experience, most of the people responsible for RIA in the technical agencies and high-tech industries are engineers and scientists who have converted from performing engineering and science to assessing engineering and science. Their training in assessment techniques ranges from minimal to non-existant. Their knowledge of the breadth of available techniques, and when to apply these techniques, is, except for a few notable cases, very limited.

Yet, the tools available for research assessment, and the conditions under which these tools should be applied, are no less complex than the analogous diagnostic tools and application conditions available to an M.D. Internist. In fact, the research assessor's operating conditions may be more complex. The Internist typically has a series of standard protocols to follow in arriving at a diagnosis. No suite of standard protocols is available to the research assessor today. How much credibility would the diagnosis of an Internist have if the Internist had training in his discipline equivalent to that of the average research assessor? The conclusion drawn here is that in order for research assessment to progress from today's practice of random application of a few well-known techniques to tomorrow's application of a suite of more sophisticated approaches tailored to specific problems, the people responsible for research assessment must have appropriate training.

Research should be addressed to the types of training which would offer preparation for assessing research from many perspectives. What are the elements of successful research assessment, and what are the educational requirements which would lead to successful research assessment? What would be the contents of the curricula; where would it be offerred? For many fields, such as Airline Pilot, Brain Surgeon, there are aptitude and personality prerequisites. Are there similar prerequisites for a potentially

successful research assessor? Finally, how should certification of research assessors be done, and enforced?

The second issue addressed is research assessment quality. In many fields, such as construction, surgery, music, quality of the product can be ascertained readily upon inspection. Yet how is quality of an RIA ascertained? One reads papers and reports which summarize RIAs, including procedures and results. From these, it is almost impossible to differentiate high from medium or low quality RIAs. How much preparation was done by the members of an evaluation panel before the actual meeting? How much background work did their leader do, and how intense was his probing, and consequently that of the panel, during the evaluation process? Was free discourse during the proceedings encouraged, or suppressed?

More research is needed into what constitutes a quality assessment. It is important to understand how these factors can be communicated in a report, and how they can be identified by independent readers.

The third generic issue is that of motivation **and associated incentives**. This issue has some overlap with the previous issue of quality. The research managers and administrators, and those with responsibility for higher level oversight, have to be convinced of the value of RIA to their organizations for the improved allocation of research resources. More important than any evaluation criteria selected is the dedication of an organization's management to the highest quality objective review, and the associated emplacement of rewards and incentives to encourage quality reviews. The team assigned responsibility to carry out RIA must be motivated to generate the highest quality product, not just 'answer the mail', as is done in many organizations today. This means selecting the best suite of methods available to accomplish organizational objectives, and selecting the most competent and objective individuals to participate in the RIA. The RIA managers must be motivated to examine the impact from as many perspectives as possible, to gain the most complete understanding. Finally, the objectives, importance, and benefits of RIA must be articulated and communicated to the researchers and research managers at the initiation of RIA, so that the reviewees will participate in the RIA as fully and as cooperatively as possible.

What are the best motivating factors for producing quality research assessments? What are the best incentives? How does one insure that the range of individuals from upper management to the person conducting the assessment remain motivated throughout the assessment process to provide the highest quality product?

The final generic issue addressed is frequency and level of detail of RIA. How frequently should research be reviewed from a cost-effectiveness viewpoint? The more frequently research is reviewed, the more chances exist to identify wayward research and redirect the efforts. However, as was shown in the text, costs of research reviews are not negligible. There is some sort of optimum point where the costs of performing the review balance the probability of achieving cost savings by identifying and re-directing or terminating wayward research. Research is required to determine

this review frequency, as a function of discipline, organization, level of basic or applied, type of performer, and other key parameters.

At what level of organization (i.e., Principal Investigator, Program, Division, Discipline, etc.) should reviews be performed, and at what frequency? Should the same RIA approach, or combinations of RIA approaches, be applied at each level of organization with the same degree of intensity and effort? Or, should the suites of RIA techniques and review frequencies be functions of the level of organization being reviewed? These are key issues of practical importance on which negligible amounts of research have been performed.

VI. RIA - SUMMARY AND CONCLUSIONS

Three generic types of RIA approaches used by the Federal government were described (semi-quantitative, peer review and quantitative methods). Peer review is the method used most frequently. All methods examined have their unique shortcomings. A fundamental problem is that many research impact targets exist. These include impact on: research field itself; allied research fields; technology; systems; operations; education; etc. The strength of the specific impact of the research on each of these targets and the weighting assigned to the value of the research impact on each of these targets depends on the technical, organizational, and personal perspectives of the reviewers. For example, while research proposal X may have a very strong potential impact on technology Y and a very weak impact on graduate student education, if the evaluators selected for a particular review are organizationally and personally inclined to assign high importance to graduate student education, then research proposal X will suffer accordingly. The many available dimensions which derive from these different perspectives serve to complicate the evaluation process.

Much of the research evaluation community has come to believe that simultaneous use of many techniques is the preferred approach. However, there is little evidence of multiple technique use by the Federal government in impact assessment, especially bibliometrics to support peer review. This area is ripe for exploitation.

A recent study (Averch, 1990) summarizes quite well the use of research impact assessments by the Federal government. "Since 1985, no breakthrough methods of any variety have been invented that more definitively reveal the ex post scientific or social value of past research investments ... the evidence is sparse that there is much payoff to public or private sector R&D administrators from making greater use of them.... R&D administrators do use ex post evaluations for political and organizational purposes, for example, to convince sponsors that they are interested in rational decision processes and that they are funding good work. However, the research evaluation literature between 1985-1990 contains very few demonstrations that evaluation makes any difference at all to the critical decisions about the level and allocation of scarce scientific and technical resources."

Finally, this Handbook has examined different research impact assessment techniques, and their use by the Federal government. The approach has been to describe application of the different techniques, and focus on the strengths and weaknesses inherent in the processes. The Handbook did not address the predictive reliability of the processes, with the exception of a short section on the predictive reliability of peer review. There is little literature which provides the basis for predicting which research programs/proposals will have the desired downstream impact. For example, the relationship between a proposal's peer review score or a project's bibliometric rating and the downstream impact on an organization's mission is not addressed in published studies. One could raise the question, as many active researchers have, as to whether there is value to any of these assessment techniques, since their predictive value is unknown. The credibility and predictability of these assessment techniques are ripe topics for research. A long term tracking system for research product evolution would be required to gather the necessary data. The system would require agreement and coordination from a number of the larger Federal research sponsoring agencies, and maybe from industrial organizations as well. While such a system would not provide absolute answers, since tracking of the informal modes of knowledge communication would be almost impossible, it would provide a much better picture of research impact and its predictability than exists now. With the present state of information storage and processing capabilities, **research product evolution tracking is an idea whose time has come.**

VII. RIA OPTIONS FOR RESEARCH SPONSORING ORGANIZATIONS

In this section, the research evaluation guidance recommended for Federal agencies is described. While the focus of this section is on Federal agency evaluations, the principles and implementation mechanics are sufficiently broad to be applicable elsewhere.

For more than a decade, the author has examined the research evaluation practices of a number of agencies and organizations. This section reflects the extraction of elements of the best of those agency and organization practices. In addition, existing and proposed methods described in prior sections are included with the extracted elements. Managers interested in applying some of the recommended approaches should tailor them to the unique needs of their organizations, to ensure that these assessment procedures are compatible with their planning and execution practices.

For ongoing periodically scheduled reviews, a tri-level agency research evaluation and impact assessment procedure for continuing and recently completed research is recommended. The main criteria used at all three levels are research quality and mission relevance. The highest level evaluation examines the total research management organization as a unit, and is an annual corporate level evaluation using external reviewers. The next level evaluation looks at individual programs (where a program is a collection of individual work units or principal investigators), and is managed by the

corporate level using external experts to perform the evaluation triennially. An option is presented for **joint evaluation of all agencies' programs in a given technical discipline.** The third level evaluation examines the individual work units, and is run less formally by the program managers periodically using internal and external reviewers.

RECOMMENDATIONS FOR FEDERAL AGENCY RESEARCH EVALUATION

A national perspective of science and technology was considered in the formulation of the recommendations. Publicly-funded science and technology should be viewed as supporting the larger long range goals of the S&T sponsoring agencies. The national objective for recommending research evaluations should be to ensure that that a horizontally (cross agency) and laterally (cross discipline) integrated national research program will lead to a global optimization for achieving the aggregated agency long range goals. Fundamental to this global optimization is the existence on a national (and perhaps on a readily accessible international) scale of an advanced pool of high quality knowledge in many research fields. As retrospective studies of research evolution to technology have shown [Kostoff, 1993d], "an advanced pool of knowledge must be developed in many fields before synthesis leading to an innovation can occur. The real critical path to the innovation is more likely the knowledge pool than any particular entrepreneur". Horizontal, lateral, and vertical (cross development phases) integration issues impact research evaluation procedures relating to global optimization, and will be discussed.

The target of global optimization for achieving aggregated agency long range goals leads to two top-level requirements which must be considered in formulating research evaluation recommendations. Is the research of high intrinsic quality and horizontally and laterally integrated among the funding agencies and balanced across the different disciplines to ensure an optimal national pool of high quality knowledge, and is the research vertically integrated within the agencies to ensure that long range agency objectives will have a maximal chance of being impacted? Horizontal and lateral integration tend to be associated with QUALITY (is the job being done right?) and vertical integration with RELEVANCE (is the right job being done?), with the ultimate assessment issue being QUALITY-RELEVANCE (is the right job being done right?).

HORIZONTAL COUPLING/ INTEGRATION

Under the present national structure of public research sponsorship, responsibility for funding any research discipline is divided up among different Federal agencies. Each agency focuses on sponsoring the research necessary to impact the agency's unique long range objectives. Because of the unified nature of research, the different components of a research discipline funded by the different agencies are related, and there are multiple relationships among

different disciplines.

From a national perspective, the aggregated research components in any research discipline should be complementary. There should be minimal duplication, and there should be minimal gaps in the research requirements and opportunities addressed for the funding available. Thus, there should be some measure of horizontal coupling among the agencies to ensure the research discipline components are complementary on a national scale.

The degree of horizontal coupling can be divided into three categories: horizontal awareness, horizontal coordination, and horizontal integration. In horizontal awareness, an agency's research managers are aware of other agencies' efforts in the discipline and plan their programs accordingly, but there is no joint planning, execution, or evaluation within the discipline. In horizontal coordination, there may be some combination of joint planning, execution, and evaluation at different intensity levels. In horizontal integration, joint efforts are strengthened while allowing each agency to retain autonomy for managing the research necessary to optimize its overall objectives.

LATERAL COUPLING/ INTEGRATION

From the national program perspective, different research disciplines which have intrinsic relationships should be conducted and managed in a complementary manner. Thus, there should be some measure of lateral (cross-discipline) intra- and inter-agency coupling to ensure that intrinsically related disciplines are complementary on a national scale.

The degree of lateral coupling can be divided into three categories: lateral awareness, lateral coordination, and lateral integration. In lateral awareness, research discipline managers are aware of other intra- and inter-agency efforts in related disciplines and plan their programs accordingly, but there is no joint planning, execution, or evaluation among the related disciplines. In lateral coordination, there may be some combination of joint planning, execution, and evaluation of related disciplines at different intensity levels. In lateral integration, joint efforts among related intra- and inter-agency disciplines are strengthened while allowing each agency to retain autonomy for managing the research to optimize its overall objectives.

VERTICAL COUPLING/ INTEGRATION

Analogous to the horizontal and lateral coupling categories are vertical coupling categories. While the main focus of vertical coupling is within a given agency, vertical coupling can transcend agencies. Because of the unified nature of research, products of research from one agency can transition to other agencies' programs. Thus, planners of vertically coupled R&D programs in one agency must be continually aware of existing and planned R&D programs of other agencies. The key point to be made is that vertical coupling is not independent of horizontal or lateral coupling. <u>Vertical integration</u>

is linked with horizontal and lateral integration. One major focus of agency research assessment from the national perspective should be the degree to which **DIAGONAL INTEGRATION** (**horizontal**, **lateral**, and **vertical** integration) is being achieved.

The vertical coupling categorization is vertical awareness, vertical coordination, and vertical integration. In vertical awareness, the research and development managers are aware of each other's efforts in the vertical structure and plan their programs accordingly, but there is no joint planning, execution, or evaluation within the structure. In vertical coordination, there is some combination of different degrees of joint planning, execution, and evaluation within the vertical structure.

Vertical integration (VI) in an S&T program is a linkage among related programs in different phases of development. Research and development programs which have a common goal are run as a unit. There could be time differences and lags between the various programs, or they could be run with different degrees of concurrence. A research component of a vertically integrated program may be undergoing execution. Its development component may be in the early planning stage, with execution well into the future. Some of the higher category components may thus exist as planning wedges while the lower category components are being executed. The development process is not linear because of the inherent feed-forward and feed-back loops within and among categories. As Attachment 1 shows, to achieve total VI, the program has to be planned and executed in a vertically integrated manner, and has to be assessed using the same taxonomy as was used for planning and execution. Because a vertically integrated program in one agency could draw upon programs managed by other agencies, the vertical linkages operate under the constraint that each agency must have management autonomy to ensure that its overall objectives are met in the most expeditious manner.

ISSUES OF QUALITY AND RELEVANCE ASSESSMENT

The issues to be considered in evaluating quality and relevance include the following. Should quality and relevance be evaluated as a unit, or evaluated separately? Should quality in a discipline be evaluated within one agency only, or should all the agencies sponsoring a discipline be evaluated as a unit? Should the quality evaluation depend on the type of vertical coupling in an agency? Should these issues have different answers depending on the evaluation level of resolution (agency, program, project)?

SPECIFIC RECOMMENDATIONS FOR AGENCY RESEARCH EVALUATION GUIDANCE

The specific recommendations for research evaluation and impact assessment guidance to Federal agencies will now be presented. The recommendations should be viewed as a threshold level, and the agencies could certainly do other types of evaluations or more complex variants than those recommended. **IT IS RECOMMENDED IN THE NOMINAL CASE THAT THE AGENCIES DO A THREE LEVEL RESEARCH EVALUATION.**

CORPORATE LEVEL REVIEW

The highest would be a corporate level review of how the agency performs research. If the agency has a separate research unit, then the unit should be evaluated as an integrated whole. If research is vertically integrated with development, then the research should preferably be evaluated as part of a total agency R&D review. However, the agency should have the option to evaluate the research unit as an integrated whole. The charter of this highest level assessment would be to review, at the corporate level, general policy, organization, budget, and programs. An example of this is the corporate NIST review [NIST, 1991a].

Total inputs and outputs would be examined. Inputs would include overall funding and people, and outputs would include the different types of research products. Integrated bibliometric indicators could be presented. Examples of Hindsight-type recent downstream impacts could be shown, as well as results of macrolevel econometric studies related to research benefits. Overall research management processes would be examined, such as selection, execution, review, and technology transfer of research. The overall investment strategy which drives the research investment would be evaluated, and would include different perspectives, crosscuts, and breakdowns of the total research program, such as technical discipline allocation, performer allocation, and end use allocation (see Attachment 2 for a more detailed discussion of the corporate investment strategy). The integration of the research objectives with the larger agency objectives would be assessed. Outstanding corporate level issues would be addressed. The evaluators would include, but not be limited to, representatives of the stakeholder, customer, and user community whose potential conflicts with the agency are minimal. To address horizontal integration, representatives of other Federal agencies would be included as evaluators.

DISCIPLINE REVIEW AT PROGRAM LEVEL

Program Definition

The second level would be peer review of a discipline or management unit at the program level. Fiscally, a program is a collection of components. These elements could be subprograms, projects, or individual work units (PIs). Conceptually, a program is greater than the sum of its components, just as the living human body is greater than the sum of its component molecules. A program includes the intelligence or inherent logic which links the components to each other and to the program's objectives, just as the living human body includes the intelligence which links the molecules to each other and to the homeostatic operation of the body. A program could be single research discipline intra- or inter-agency; multiple discipline intra- or inter-agency; multiple discipline vertically integrated intra- or inter-agency; multiple discipline multi-agency multi-national; or other variants of the above. The nominal program is assumed to be intra-agency; multi-agency programs are discussed later in this Handbook. The nominal review is assumed

to be intra-agency. Some organizations review by disciplines, some organizations review by multi-discipline management unit, and in some organizations disciplines coincide with management units.

Program Review Options

The guiding principle for review options is that evaluation should occur along the same structures and taxonomies by which the research is planned and executed. If the agency has a separate research unit, then the discipline should be evaluated as an integrated whole. In the nominal intra-agency review, quality and relevance could be evaluated concurrently or separately, as desired by the agency.

If research is vertically integrated with development, then the research could be evaluated as part of a total vertical structure R&D review (characteristics of an assessment of such a vertically integrated structure are discussed in Attachment 5) or as part of the discipline, as desired by the agency. In the nominal intra-agency review, quality and relevance could be evaluated separately or concurrently. A key conclusion to be drawn from this paragraph is that research evaluation recommendations must take into account how research is structured, integrated, and managed within an agency.

Desirable characteristics of a high quality peer review were listed previously, and are repeated in Attachment 3. The review protocol principles suggested for this level were listed previously, and are repeated in Attachment 4. The research programs should be reviewed on a trienniel cycle, based on the DOE BES evaluation results of 1982, and on other agency practices.

The following considerations apply to a concurrent quality and relevance review. The reviewers should be external, have minimal conflicts with the program being reviewed, and should be selected with expertise in all facets of the research and potential impact areas. To evaluate the degree of horizontal coupling in the nominal intra-agency review, representative of other Federal agencies should be considered as reviewers, or at least should be invited to participate as audience members. Thus, the review panel will be a heterogeneous mixture of research and relevance experts who can address the many facets of the science and areas of potential impact. Approaches for selecting a review panel are presented in Attachment 6.

In the nominal concurrent quality and relevance review, quality and relevance should be the main review criteria. Research quality criteria should include research merit, research approach, productivity, and team quality. Relevance criteria should include short term impact (transitions and/or utility), long term potential impact, and some estimate of the probability of success of attaining each type of impact. Some issues to be kept in mind by the reviewers during the presentations are listed in Attachment 7.

There should be an overview showing how the larger management unit (Division, Department, etc.) in which the programs are housed integrates into the total organization, and how the management unit's objectives relate to those of the larger organization. Then, the investment strategy of the larger management unit should be presented

in detail. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. Finally, for each program presentation, the investment strategy for its thrust areas should be presented.

The investment strategy is perhaps the most crucial part of a program review, and deserves further discussion here. While investment is the allocation of resources among the program components, the investment strategy is the rationale for the prioritization and allocation of resources among the program components. The optimal investment strategy for a program, which should be a focal point of an assessment, is that allocation and rationale which will produce the most mission relevant high quality research for impacting the program's objectives. This will depend on the viewpoint of the assessor, and in particular how the assessor limits the role of the research within the national perspective.

The optimal investment strategy results from a timely confluence of research requirements (top-down driven) and promising research opportunities (bottom-up driven). Further, promising research opportunities result from a timely confluence of advances in theory, instrumentation, new experiments, new algorithms, and computers. Finally, research requirements result from a timely confluence of domestic and foreign, political and economic, strategic and tactical advances. All of the above factors should be included in a presentation of the investment strategy.

While the emphasis is on peer review, bibliometric and other type of indicators should be utilized. In the protocol, it is recommended strongly that sufficient background material be supplied to the reviewers before the review. This would include organizational descriptive material, narrative descriptions of each program to be reviewed, and descriptive material of each work unit in the program. It would also prove useful to include bibliometric output indicators for each program, with interpretive analytical material. This could include refereed papers, patents, awards and honors, presentations, etc. It would be useful to include narrative material on related programs in other agencies and industry. It would be useful to include Hindsight-type results of research that was funded years ago in the discipline under review and which recently came to fruition in a system or commercial technology. To track these in a credible manner would require the research product evolution tracking database referred to previously. This concept was described by the author in a little more detail in a published paper, and is reproduced in Attachment 8. Sample guidance for a concurrent quality/ relevance program review is presented in Attachment 9.

In the detailed guidance example in Attachment 9, it is recommended that program managers include roadmaps with their technical presentations. It would be very valuable if the roadmaps were provided as background material as well. These roadmaps provide the global context in which the program is being performed. Their retrospective components show how aware the program manager is of the breadth and depth of the intellectual heritage of the present program; the present components reflect the awareness of the program

manager of the wide range of science and technology areas available to complement his program, and the degree of coordination and leveraging in which his program is involved; the prospective roadmap components provide indication of the program manager's vision and willingness to take risks, and his intrinsic understanding of how results from other science and technology programs could be exploited to enhance and expand the potential of his program. A certain amount of time and reflection is required to understand and fully appreciate the implications of a comprehensive roadmap, and the reviewers should receive these roadmaps well in advance of the actual review date. For the reader interested in obtaining more information about diverse aspects of roadmaps, a comprehensive document has been prepared replete with concepts, principles, and examples [Kostoff, 1997d].

Finally, although the following concept has never been tested to the author's knowledge, it would be valuable to incorporate the results of journal manuscript reviews in the research program peer review process. Attachment 19 outlines the benefits of such a proposal, and outlines how it could be accomplished.

Inter-Agency Review Option

The nominal review is assumed to be intra-agency. If coordinations could be effected, a more useful approach from the integrated national perspective would be to review technical disciplines on a national level. This would allow horizontal integration to be assessed more readily. The focus of this inter-agency review would be research quality.

Under this option, a separate intra-agency review would address mission relevance of the technical disciplines, either by themselves or as part of vertically integrated structures. For purposes of the present discussion, it is assumed that the mission relevance review for each technical discipline would precede the inter-agency research quality review for that discipline. As a result, the research requirements necessary to address mission needs would be identified by the time of the inter-agency review.

One scenario for, say, an inter-agency review of Chemistry would be the following. All agencies which had major Chemistry programs would be reviewed together. One third of the total Chemistry discipline would be reviewed each year. A large panel consisting of research experts would be convened. The research experts would participate in all program reviews except where obvious conflicts of interest arose. This type of review would give a perspective on the national program unattainable by any single agency review. One major outcome would be identification of Chemistry science research gaps in the national program.

One complication of such an inter-agency review arises from the lateral integration issue. For a program which is planned and executed as a multi-category (R&D) and/or multi-research discipline program, is it reasonable to isolate a particular research discipline and have it reviewed for quality as part of a multi-agency review? If a multi-category program had a separate relevance review within the agency, then a detailed quality review of each of the categories could and should be performed. For research which is conducted as

part of a multi-disciplinary program, the research quality of the multi-disciplinary unit should be examined. This would require that the research expertise on the panel not be confined to the major discipline being evaluated, but should include experts from the other research areas. This is true even for intra-agency multi-discipline reviews. For the inter-agency nominal single discipline reviews suggested, integrated multi-discipline reviews would require that experts from disciplines other than the dominant discipline be brought in for specific multi-disciplinary programs. While this would make the logistics of the inter-agency review more complex, if programs with similar multi-discipline profiles are grouped appropriately, the review could be performed more efficiently.

If this full multi-discipline program review proves to be too complex because of time and reviewer logistics constraints, then only the single discipline component of the multi-discipline program could be reviewed at the inter-agency single discipline review. The other disciplines of the multi-discipline program would be summarized to provide context for the single discipline component being reviewed, but they would not be subject to review at this time. They would be reviewed when their own single discipline inter-agency reviews occurred. If an objective of research assessments on a national scale is to ascertain whether programs are complementary from horizontal, lateral, and vertical perspectives, then there will be many complexities of the type just described which will have to be addressed. Having many different types of integrated programs will require special conditions and creativeness to review each type.

Continuing on the inter-agency Chemistry review example, at the end of the inter-agency review, the panel would meet to identify promising research opportunities in the Chemistry discipline. The panel would be well-positioned to generate these opportunities, for they would have heard the total program, and seen the research gaps. They would provide recommendations to the agency program managers at the end of their meeting for the promising Chemistry research opportunities to be pursued.

Immediately following this panel meeting, the Chemistry program managers from the agencies would convene a joint planning meeting. With the research requirements based on mission needs and the research opportunities based on science needs in hand from the intra- and inter-agency reviews, the panel would outline the structure of a complementary horizontally-integrated multiagency Chemistry program. This very preliminary structure would have to be iterated within each agency over a period of months to ensure coordination with other R&D programs within the agency and to ensure funding priorities and constraints are observed. Nevertheless, this initial structure would provide a cohesive and comprehensive springboard from which the final integrated programs could be developed.

If this whole process is scheduled well, then immediately following the planning meeting would be the annual American Chemical Society meeting. The overall results of the intra- and inter-agency Chemistry reviews, the research requirements and opportunities identified, and the very preliminary program plans would be presented to the Society at the opening plenary session. This could last a

day, and valuable feedback, dialogue, and interchange could be generated. The above process has the desired feature of integrating planning and assessment, and brings in the total community as process participants.

DISCIPLINE REVIEWS AT WORK UNIT LEVEL

The third level of review would be at the work unit (PI) level. The nominal case would be less formal intra-agency reviews conducted at the program manager level, but if an agency wanted a more formal review conducted at the corporate level, such as the DOE BES review, they would certainly have the prerogative to do so. If an agency wanted this more formal work unit level review, then it would be most efficient to combine it with a program level review. Most of the program level issues described above, including the potential for multiagency reviews at more focused workshops or conferences, are applicable and need not be repeated.

An example of a high quality well-documented and established approach for evaluating existing work units is the procedure developed by DOE. Its protocol is reproduced in Attachment 11.

This procedure can be modified for evaluating proposed projects, and existing and proposed programs. The author participated in the development of the DOE process, and modified it for program evaluation when he came to ONR. In the modification, the author served as Chairman of the review panels, received individual inputs from the panelists, and wrote the final report. The panels were typically larger than the DOE panels, averaging about a dozen people in size, and had more representation from the customer, stakeholder, user, and impactee communities. Some of the review criteria and definitions were modified.

Attachments 12-15 contain sample evaluation scoring forms used by the author in the evaluation of existing and proposed programs. Attachment 12 is a long form used in the evaluation of existing programs. The long form has two purposes. It requires the reviewer to consider quantitatively the different components of quality and relevance. It also allows the sponsoring agency to perform analyses on the scores, to identify which component criteria the reviewers thought were most important. Attachment 16 contains an analysis of reviewers' scores for proposed programs (see Kostoff [1992a]-Appendix II for a more detailed treatment).

If an ad hoc review of an existing program is required, where there are specific issues of concern rather than the generic issues characteristic of periodically scheduled reviews, then a different evaluation form type may be used. Attachment 17 contains the criteria and forms that could be used for ad hoc evaluation of a more applied research program. Here, the focus is on the specific issues of concern. Ratings could be applied to each issue; they are not shown in this attachment. The issues shown in Attachment 7 would also be utilized in this review.

Many labs, companies, and sponsoring agencies have special programs which consist of many small, high risk, finite duration projects. These 'seed-money' projects, because of their special

nature and small size, require special review techniques for cost-effective assessment. A protocol for reviewing these types of projects is contained in Attachment 18. To streamline these reviews, expanded use of journal papers peer reviewers' comments during project reviews is proposed in Attachment 19.

MULTI-AGENCY PROGRAM ASSESSMENTS

The previous section dealt mainly with intra-agency programs. There are, however, programs which are inter-agency, and they can be fairly large programs. If these programs are planned as a unit, they should be assessed as a unit. The issues which were discussed for program evaluation in the previous sections, where intra-agency programs were considered as the evaluation unit, apply here equally well to the inter-agency program considered as the evaluation unit. These issues include concurrent or separate quality and relevance reviews, and intra- or inter-agency quality reviews.

OTHER CONSIDERATIONS

High quality assessments at any of the above levels are expensive and time consuming. Attachment 10 contains a peer review cost example presented previously. The agencies should make every effort to minimize program disruption and review costs while performing credible assessments.

A practical consideration concerns the length of the review. It is desirable to have the same group of reviewers present for the total review of the areas in which they have expertise. This allows normalization and continuity to occur. However, in the case of a program review, the larger the program, the more review time it will require. It becomes more difficult to retain high quality reviewers as the length of the review increases.

There are at least three approaches to circumvent this problem. First, the program could be broken into focused subprograms, and each subprogram could be reviewed separately with more focused experts. Second, the program could have its components aggregated, and the full program could be reviewed by the same panel at a lower level of detail. Third, the quality and relevance components could be divided for separate reviews. **In the inter-agency review example for Chemistry described above, if the review required weeks, then more focused reviews of smaller units might be appropriate.**

The length of the review will be governed by the desired resolution detail of the technical area presentations. Two indicators are of value in the discussion of resolution detail. These are Spatial Presentation Intensity (SPI) and Temporal Presentation Intensity (TPI). The SPI is the ratio of total dollar value of the program being reviewed to the number of reviewers, and the TPI is the ratio of total dollar value of the program being reviewed to total hours allotted to the review.

For the most detailed review, a review at the Principal Investigator (PI) level, the TPI should range from about $125K to $250K per hour (one to two projects per hour), and the SPI should

range from about $100K to $250K per reviewer. These reviews could cover technical quality and agency relevance. For the second level detail of review, a program review which would cover both in-depth technical quality and agency relevance, both the SPI and TPI should range between $1M and $1.5M ($/reviewer, $/hour). The third level detail of review, a program review which would be a presentation aggregation of the second level of review and would cover agency relevance only, would have both the SPI and TPI range between $4M and $5M ($/reviewer, $/hour). The TPI estimates are based on review durations of one or more days, while the SPI estimates are based on one-day reviews. If the same reviewers are used for multi-day reviews, the SPI numbers increase sharply. Thus, if an agency wanted to do an in-depth technical quality and agency relevance review at the program level of a $50M program, then about 35-50 hours of presentation time would be required. If a different panel were used each day, then about 35-50 reviewers would be required, whereas if the same panel were used for the total review, then realistically about ten reviewers would be required.

Many agencies do quantitative evaluations of their research. The actions they take appear to be on the basis of the qualitative results, but it is not clear how use is made of the quantitative results. A method for translating the quantitative scores into funding reallocations on a uniform, consistent agency-wide basis, making use of existing computer hardware and software capabilities, is presented in Attachment 20.

Finally, there is considerable interest at present in expanding the use of quantitative indicators of research impact. While the quantitative methods described in the first part of this Handbook focus on the magnitude of the indicators, there do not appear to be methods which attempt to quantify the patterns which underly the indicator magnitudes. For example, citation counts are tabulated in citation analysis, but few, if any, studies address the patterns of citation impact on different fields, journals, institutions, etc.

One concept which has been used in statistical thermodynamics and information theory to quantify and analyze patterns is entropy. Attachment 21 addresses the potential use of entropy and entropy gradients in different aspects of research evaluation and impact assessment. Two examples are presented, and it is shown that in some cases supplementation of entropy with indicators such as moments of the pattern distribution functions is quite useful.

Attachment 1 - REQUIREMENTS FOR VERTICAL INTEGRATION

For total vertical integration to be achieved, two conditions are required. Both **intrinsic** vertical integration and extrinsic vertical integration are necessary. Intrinsic vertical integration occurs when program planning and execution have been done in a vertically integrated manner, and the vertical integration goals have been achieved. **Extrinsic** vertical integration is the <u>verification</u> of intrinsic vertical integration. Extrinsic vertical integration results from positive assessment of a program using coordination and integration measurement criteria.

There are many aspects to bringing a vertically integrated program to fruition, including planning, execution/ transition, and assessment. Unless planning, execution, and assessment are coordinated among each other, among performing organizations, and among levels of development, there is little chance that an agency's total program will be performed and perceived in a vertically integrated mode.

If a program is not planned and executed as vertically integrated (not intrinsically VI), it will not be verified as vertically integrated by assessment (not extrinsically VI). If a program is planned and executed as vertically integrated (intrinsically VI), it may or may not be verified as vertically integrated by assessment. The outcome will depend on how the assessment is performed. To achieve extrinsic VI in this case, planning, execution, and assessment have to be based on the same or a readily connected taxonomy **(A taxonomy is a classification scheme).** In particular, if planning is done using one taxonomy, and assessment is done using an unrelated taxonomy, then the assessment results will be <u>predetermined</u> to show an uncoordinated and non-integrated S&T effort. Thus, to achieve total VI, the program has to be planned and executed in a vertically integrated manner, and has to be assessed using the same taxonomy as was used for planning and execution. Because a vertically integrated program in one agency could draw upon programs managed by other agencies, the vertical linkages operate under the constraint that each agency must have management autonomy to ensure that its overall objectives are met in the most expeditious manner.

Attachment 2 - CORPORATE INVESTMENT STRATEGY

The investment strategy for an agency should be an iterative procedure which converges when the 'top-down' requirements driven component synchronizes with the 'bottom-up' opportunities component. The 'top-down' component of the investment strategy document should start by describing the generic principles which guide the agency's investments. It should then summarize the major global and domestic events which influence the direction of the agency's investments. This provides the context in which the actual investment strategy is generated. Then the prioritized mission requirements are specified. A translation is made from these prioritized mission requirements to a prioritized set of research and technology requirements.

The above procedure constitutes the first step in the 'top-down' component. In parallel, the 'bottom-up' component is developed. The research areas in which the agency has strategic interest should be assessed. The confluence of leading-edge research theory, experiments, computational capabilities, and instrumentation should be identified to provide the most timely promising research opportunities of interest to the agency.

The technical program areas which address these research and technology requirements and opportunities are developed, and the priorities among these areas are established. Funding allocations among these areas are made, and the rationale for the funding allocations based on these priorities is provided in detail.

SAMPLE INVESTMENT PRINCIPLES

The major strategic generic investment principles which guide the agency's investments can be summarized in the following manner:

1. Maintain diversied portfolio of broad spectrum R&D to deal with future uncertainties, develop breakthroughs, and rapidly exploit foreign breakthroughs
2. Allocate X% of the investment to high-risk high-payoff programs
3. Allocate Y% of the investment to requirements-driven programs
4. Provide stable funding to maintain program integrity
5. Focus investment on medium to long-term payoffs
6. Leverage other agency/government programs when possible
7. Maintain awareness of other agency/government S&T programs when selecting, reviewing, and terminating S&T programs
8. Use external reviewers from the larger technical community when selecting and reviewing agency technical programs
9. Plan, execute, and review agency technical programs to maximize vertical and lateral integration
10. Support training of future agency mission essential workforce
11. Maintain critical industrial base which could be activated in times of national emergency
12. Maintain threshold S&T infrastructure which focuses on essential S&T programs and provides an in-house window to the larger

technical community

INVESTMENT STRATEGY CROSSCUTS AND BREAKDOWNS

In tandem with the principles stated above is the need to show how the principles are expressed in actual funding allocations. To display this coupling, a number of different crosscuts through the program are necessary. A few of these crosscuts are suggested below.

CROSSCUTS

1. Science Disciplines
2. Mission Areas
3. Core Competencies
4. Claimants
5. Performers
6. Revolutionary/ Evolutionary
7. Basic/ Applied
8. Level of Risk**
9. Congressional/ Administration Priorities/ Thrusts
10. Multi-Agency Applications
11. Coordination with other Agencies/ Organizations/ Countries

The crosscut with the double-asterisk**, Level of Risk, is very important in the evaluation of Federal programs and is typically very difficult for agencies to evaluate. The remainder of this section discusses the importance of identifying research risk, presents results of experiments in categorizing program risk, and shows how these categories can be utilized to support investment decisions.

BACKGROUND

Investment in research projects is intrinsically a risky venture. Not only is there the technical risk associated with the research approach and the downstream technology development uncertainties, but there are risks associated with the market and geopolitical environments which affect the financing and eventual utilization of the resultant technologies. A full risk analysis for purposes of research project selection and continuation should incorporate all these risk factors.

The present section focuses on identification of technical risk of projects in their research phase. In particular, it focuses on one component of technical risk, the research technical risk. Research risk is defined as the probability that pre-defined research objectives will be attained at a specified cost at a specified time. This risk component is typically very difficult for any research sponsoring organization to estimate. To develop a more rigorous and normalized approach to research technical risk level estimation, the author has examined hundreds of research program narratives in conjunction with the program managers, and has utilized different approaches to classify the research program risk levels. These experiments with categorizing risk have shown that the following seven major risk categories provide a comprehensive taxonomy.

1) Large extrapolations;
2) Difficult data gathering;
3) Additional complexities required;
4) High precision required;
5) Breakthroughs required;
6) Theories insufficient;
7) Record of past difficulties.

INTRINSIC DIFFERENCES BETWEEN HIGH AND LOW RISK PROGRAMS

The high-risk programs differ from the low-risk programs because larger steps into the unknown are required to achieve the research objectives. The basic mechanisms which would allow the attainment of the research objectives for high-risk programs have greater uncertainty than for low-risk programs. There is some overlap among these risk categories, many of the programs could be placed in more than one of the categories, and some of the categories could be subsumed under other categories. In particular, category 7 (Record of past difficulties) could be included in many of the other categories, as could category 5 (Breakthroughs required). Nevertheless, a discussion of all seven of these categories provides a deeper understanding of research risk than is possible from the definitions alone.

SEVEN MAJOR CATEGORIES OF RISK

1) Large extrapolations

In this category, the risks arose from the large extrapolations required to proceed from present levels of understanding to the attainment of specified research targets. There could be extrapolations in size (e.g., achieve plasma stabilities over long distances after stabilities over short distances have been obtained), and/or in time (extend energy transfer measurements from the nanosecond regime to the femtosecond regime), and/or in operational parameters (understand material response in extended portions of the frequency spectrum), and/or in geographical regions (take measurements in hostile North Atlantic environment after measurements in warmer latitudes have been completed).

2) Difficult data gathering

The risks in this category arose from the difficulty of obtaining useful data. The data gathering environment could be harsh and hostile (e.g., environmental measurements during space vehicle atmospheric re-entry), and/or the signal to noise ratio could be small, and/or the instrument resolution might not be sufficient, and/or the experiments could be very expensive (e.g., winter experiments in the Arctic). In addition, the data required could be very sporadic (fast-rising storm data), the appropriate variables to measure might be unknown, the instruments may have been unproven in the required operational environment (e.g., an instrument which worked well in a laboratory is now required to operate in a much harsher aircraft environment), and the instruments may not have been

sufficiently ruggedized for the operational environment to provide useful data. In some cases, the scales of the data to be taken might not be known; there may be questions as to whether the correct instruments were being utilized. Finally, the volumes of data required for a useful experiment may be beyond the capacities of present instruments, and in this case, as well as in many others, instrument breakthroughs may be required.

3) Additional complexities required

In this category, the incorporation of different types of complexities in the research problem greatly increased the uncertainty of its resolution. Issues arising from the different component disciplines might require simultaneous resolution; i., e., multiple discipline advances might be required, and coordinated teams of experts from multiple disciplines might be required. There could be uncertainty as to whether all relevant processes were being modeled. Multi-scale interaction and coupling mechanisms might not be known. In some cases, the complexity of the problem could verge on being unmanageable. Because of the multidiscipline interrelationships in some cases, there could be questions as to whether one objective of the multidisciplinary effort could be attained without compromising other objectives.

4) High precision required

This risk factor had two components. First, the data accuracy controls could be too demanding. For example, a system of many elements could require unacceptably high operational tolerances for each component before the overall system could operate as predicted. Second, the process data could be sufficiently variable that predictive models could not be constructed to produce reasonable estimates.

5) Breakthroughs required

This factor is the quintessence of high risk, especially if breakthroughs resulting in orders of magnitude improvement are required, and permeates the other risk factors. Types of breakthroughs which could be required include totally new materials, new numerical methods, and new computing capabilities.

6) Theories insufficient

This factor concerns the upgrading of present theories. The present theories might not be sufficient to incorporate the additional phenomena. Theories might be required to incorporate phenomena which were heretofore unmodeled. There may be insufficient understanding, or identification of all process phenomena, required to produce a universal theory or approach. Theories developed in other disciplines for other purposes may have to be tried. Models may not exist to explain experimental observations. Theories may have to encompass discrete and continuum behavior. Convergent algorithms may not exist, and errors resulting from assumptions or data sources may not be estimatible.

7) Record of past difficulties

This factor may be a derived quantity, i.e., a program has a 'record of past difficulties' because of one or more of the other risk factors. Much of this factor relates to the absence of any positive track record in achieving the desired research objectives. Many past attempts may have failed (e.g., Boron propellant, supersonic combustion). The approach chosen might go against conventional wisdom and against recent trends in field. The approach may be unproven at any level, and the feasibility of the new approach may not be obvious. Only a qualitative understanding may exist, and multiple approaches may be required due to uncertainty of operation of any single approach. While different parameter values may have been obtained separately, all required parameter values may not have been attained in one system.

UTILIZATION OF RISK LEVELS IN PROGRAM ASSESSMENT AND SELECTION

The private sector uses quantified representations of risk extensively in its decision making process. As an example, consider one of the more popular evaluation approaches for project selection, Net Present Value (NPV). This process discounts all of a project's estimated costs and benefits to today's dollars, using a discount rate.

One approach used to incorporate total risk into NPV is to increase the discount rate with increasing risk. As the rate (and risk) increases, short-term payoffs become more and more attractive. This is one reason that basic research, with its attendent high levels of risk and uncertainty and long payoff time horizons, has declined under industrial sponsorship for the last few decades. In the increasingly competitive global environment, companies find it increasingly difficult to justify funding investments with low discounted values [Kostoff, 1996c].

Another approach to incorporating total risk into NPV is to keep the discount rate at some low risk or risk free level (such as a U. S. Bond rate), and incorporate the added risk factor into the expected level of the project's payoff [Kostoff, 1983]. Thus, if a project is estimated to have a 50 percent probability of achieving a ten million dollar payoff, with all risk factors being included, then the expected value of its payoff is five million dollars.

This expected payoff value approach to incorporating risk into NPV will be used to illustrate how a project's risk can be quantified utilizing the above risk taxonomy. Assume a project at the research proposal stage has a potential ten million dollar payoff. For purposes of this discussion, neglect the non-technical components of risk. Assume the total technical risk can be divided into two components, research risk and technology risk. Research risk has been defined above. Technology risk is defined here as the probability that the commercial system's technical performance objectives can be attained (assuming the research cost/ performance/ schedule objectives have been attained successfully) at a specified cost at a specified time. Thus, the total risk will be the product of the research and technology risks.

Assume two of the above research risk categories (#4 and #2) contribute to the research risk. If these categories are independent (e.g., a very high precision component is required [#4], and it will be part of an experiment which operates in a very hostile environment [#2]), then the research risk will be the product of these category probabilities. Thus, if the probability of success in achieving the high precision component is one out of two, and the probability of successful operation in the hostile environment is one out of two, then the research probability of success will be one out of four. If the categories are not fully independent, then more complex probability analyses are required.

To compute the total technical risk in the case where the categories are independent, assume there is a one in four chance that the research objectives can be attained on cost and schedule (the result of the previous paragraph), and, if these objectives are attained, there is a one in three chance that the technology objectives can be attained on cost and schedule. Then, from the vantage point of the research proposal stage, there is a one in twelve chance that the potential ten million dollar payoff will be realized, and the expected value of the payoff in this case is 833 thousand dollars.

For fundamental research, either of these quantitative economic approaches has to be employed cautiously. Risk tends to be high, and the uncertainty in the projected cost and benefit streams is high, so that any numerical results are very uncertain (Kostoff, 1995a). For development projects, the uncertainty is reduced, and the results of parametric studies are substantially more credible.

Attachment 3 - DESIRABLE CHARACTERISTICS OF QUALITY PEER REVIEW

The desirable characteristics of a peer review can be summarized as [Chubin, 1994]:

1. an effective resource allocation mechanism;
2. an efficient resource allocator;
3. a promoter of science accountability;
4. a mechanism for policymakers to direct scientific effort;
5. a rational process;
6. a fair process;
7. a valid and reliable measure of scientific performance.

High quality peer reviews require as a minimum the conditions summarized from Ormala [1989]:

1. The method, organization and criteria for an evaluation should be chosen and adjusted to the particular evaluation situation;
2. Different levels of evaluation require different evaluation methods;
3. Program and project goals are an important consideration when an evaluation study is carried out;
4. The basic motive behind an evaluation and the relationships between an evaluation and decision making should be openly communicated to all the parties involved;
5. The aims of an evaluation should be explicitly formulated;
6. The credibility of an evaluation should always be carefully established;
7. The prerequisites for the effective utilization of evaluation results should be taken into consideration in evaluation design.

Assuming these considerations have been taken into account, **three of the most important intangible factors for a successful peer review are: Motivation, Competence, and Independence** [Kostoff, 1994l]. The review leader's motivation to conduct a technically credible review is the cornerstone of a successful review. The leader selects the reviewers, summarizes their comments, guides the questions and discussions in a panel review, and makes recommendations about whether the proposal should be funded. The quality of a review will never go beyond the competence of the reviewers. Two dimensions of competence which should be considered for a research review are the individual reviewer's technical competence for the subject area, and the competence of the review group as a body to cover the different facets of research issues (other research impacts, technology and mission considerations and impacts, infrastructure, political and social impacts). The quality of a review is limited by the biases and conflicts of the reviewers. The biases and conflicts of the reviewers selected should be known to the leader and to each other.

Attachment 4 - REVIEW PROTOCOL FOR SUCCESSFUL PEER REVIEW

This section contains a protocol developed by the author for the conduct of successful peer review research evaluations and impact assessments. The main aims of the protocol are to ensure that the final assessment product has the highest intrinsic quality and that the assessment process and product are perceived as having the highest possible credibility. The protocol elements are:

1. The objectives of the assessment must be stated clearly and unambiguously at the initiation of the assessment by the highest levels of management, and the full support of top management must be given to the assessment. In turn, the objectives, importance, and urgency of the assessment must be articulated and communicated down the management hierarchy to the research managers and performers whose research is to be assessed, and the cooperation of these reviewees in the conduct of the assessment must be enlisted at the earliest stages of the assessment;

2. The final assessment product, the audience for the product, and the use to be made of the product by the audience should be considered carefully in the design of the assessment;

3. One person should be assigned to manage the assessment at the earliest stage, and this person should be given full authority and responsibility for the assessment;

4. The assessment manager should report to the highest organizational level possible in order to ensure maximum independence from the research units being assessed;

5. The reviewers should be selected to represent a wide variety of viewpoints, in order to address the many different facets of research and its impact. The reviewers should be independent of the research units being evaluated, and independent of the assessing organization where possible. The objectives of, and constraints on (if any), the assessment should be communicated to the reviewers at the initial contact;

6. Maximum background material describing the research to be assessed, related research and technology development sponsored by external organizations, the organization, and other factors pertinent to the assessment, should be provided to the reviewers as early as possible before the review. This will allow the reviewers and presenters to use their time most productively during the review;

7. Recommendations resulting from the assessment should be tracked to ensure that they are considered and implemented, where appropriate. For research programs, planning, execution, and review are linked intimately. Feedback from the review outcomes to planning for the next cycle should be tracked to ensure that the review/planning coupling is operable.

Attachment 5 - PROTOCOL FOR VERTICALLY INTEGRATED PROGRAM RELEVANCE ASSESSMENT

The main focus of a vertically integrated program assessment is to review program coordination and integration, and relevance to agency mission requirements, but not detailed technical quality. The following protocol has been developed to focus on a vertically integrated program relevance assessment, where program can be interpreted as a single program or group of programs centered around a vertically structured theme.

The protocol from Attachment 4 is repeated here with some additions. These additions are shown in capital letters. Some of the additions apply equally well to quality and relevance assessments. Those additions which apply mainly to vertically integrated program relevance assessments are underlined as well.

1) Communication of Assessment Objectives

The objectives of the assessment must be stated clearly and unambiguously at the initiation of the assessment by the highest levels of management, and the full support of top management must be given to the assessment. In turn, the objectives, importance, and urgency of the assessment must be articulated and communicated down the management hierarchy to the research managers and performers whose research is to be assessed, and the cooperation of these reviewees in the conduct of the assessment must be enlisted at the earliest stages of the assessment;

2) End Use of Assessment Product

The final assessment product, the audience for the product, and the use to be made of the product by the audience should be considered carefully in the design of the assessment;

3) Management Structure for Assessment

One person should be assigned to manage the assessment at the earliest stage, and this person should be given full authority and responsibility for the assessment;

The assessment manager should report to the highest organizational level possible in order to ensure maximum independence from the research units being assessed;

4) Criteria for Reviewer Selection

The reviewers should be selected to represent a wide variety of viewpoints, in order to address the many different facets of research and its impact. The reviewers should be independent of the research units being evaluated, and independent of the assessing organization where possible. The objectives of, and constraints on (if any), the assessment should be communicated to the reviewers at the initial contact;

THE TERMS OF REFERENCE SHOULD SPECIFY WHAT IS DESIRED FROM THE REVIEWERS. A TIMELINE OF CRITICAL ASSESSMENT EVENTS SHOULD BE GENERATED SHORTLY AFTER THE TERMS OF REFERENCE ARE APPROVED.

5) Guidance to Presenters

PRECISE GUIDANCE SHOULD BE PROVIDED TO THE PRESENTERS AT THE EARLIEST STAGES OF THE ASSESSMENT. THIS WILL GIVE THEM ADEQUATE TIME TO GENERATE A COORDINATED SET OF PRESENTATIONS AND TO GIVE SUFFICIENT 'DRY RUNS' UNTIL THEY CONVERGE TO AN ACCEPTABLE PRODUCT. SAMPLE GUIDANCE (BOLDED) FOR A HYPOTHETICAL THREE LEVEL HIERARCHICAL PRESENTATION STRUCTURE FOLLOWS.

THE PURPOSE OF THE REVIEW WILL BE FIVEFOLD: ASSESS TECHNICAL QUALITY, FOCUS, SCOPE, AND BALANCE OF AGENCY S&T PROGRAMS IN SUPPORT OF MISSION REQUIREMENTS; ASSESS THE RESPONSIVENESS AND COMPLETENESS OF THESE PROGRAMS IN RELATION TO EXISTING AND ANTICIPATED AGENCY MISSION NEEDS; ASSESS HOW THESE PROGRAMS ARE COORDINATED AND INTEGRATED, BOTH HORIZONTALLY AND VERTICALLY; IDENTIFY DUPLICATION AND/OR GAPS IN THESE PROGRAMS IN RELATION TO AGENCY MISSION REQUIREMENTS; ASSESS LEVERAGING BY AGENCY OF OTHER PROGRAMS, BOTH INTERNAL AND EXTERNAL.

THERE WILL BE THREE LEVELS OF SPEAKERS MAKING THE TECHNICAL PROGRAM PRESENTATION. THE LEVEL 1 SPEAKER, WHO MANAGES THE VERTICAL STRUCTURE, WILL PRESENT THE VERTICAL STRUCTURE OVERVIEW. THE REMAINDER OF THIS GUIDANCE PERTAINS TO THE SPEAKERS AT THE NEXT TWO LEVELS. THE LEVEL 2 SPEAKERS, WHO ARE SUB-MANAGERS OF THE VERTICAL STRUCTURE, WILL PRESENT OVERVIEWS OF THE MAIN VERTICAL STRUCTURE COMPONENTS. IN THE AGENDA, A NUMBER OF SUB-AREAS WITH IDENTIFIED SPEAKERS ARE LISTED UNDER EACH OF THE MAIN AREAS. THE SPEAKERS LISTED FOR THESE SUB-AREAS ARE IDENTIFIED AS THE LEVEL 3 SPEAKERS. EACH OF THE LEVEL 2 SPEAKERS SHOULD MEET WITH THE LEVEL 3 SPEAKERS AS SOON AS IS POSSIBLE, TO COORDINATE THE PRESENTATIONS. IT IS EXPECTED THAT THE LEVEL 3 SPEAKERS WILL ADDRESS A COMBINATION OF SCIENCE AND TECHNOLOGY PROGRAMS IN AN INTEGRATED MANNER.

THE LEVEL 2 SPEAKERS WILL BEGIN THEIR PRESENTATION BY RELATING THEIR OBJECTIVES TO THOSE IDENTIFIED IN THE LEVEL 1 SPEAKER'S OVERVIEW PRESENTATION. THEN, THE LEVEL 2 SPEAKERS SHOULD PRESENT ONE OR MORE VIEWGRAPHS IN EACH OF THE FOLLOWING TOPICS. THEY SHOULD DESCRIBE THE INVESTMENT STRATEGY AMONG THE DIFFERENT SUB-AREAS. THE INVESTMENT STRATEGY INCLUDES THE DOLLARS ALLOCATED TO EACH OF THE SUB-AREAS, AS WELL AS A RATIONALE FOR THE ALLOCATION. THE DOLLARS ALLOCATED SHOULD BE PRESENTED IN TABULAR FORM FOR FY9X - FY9Y, WITH FUNDS FOR THE SCIENCE AND TECHNOLOGY CATEGORIES BROKEN OUT. INCLUDED IN THE INVESTMENT STRATEGY WILL BE A DESCRIPTION OF HOW THE AGENCY PROGRAM RELATES TO OTHER AGENCY, INDUSTRY, AND OTHER COUNTRY PROGRAMS AND PROJECTS. NEXT, THE BROAD S&T OBJECTIVES OF THE DIFFERENT SUB-AREAS WILL BE IDENTIFIED. THE PURPOSE IS TO SET THE STAGE FOR THE MORE DETAILED PRESENTATIONS OF THE SUB-AREA SPEAKERS WHICH ARE TO FOLLOW. THE THIRD TOPIC IS THE COORDINATION AND INTEGRATION AMONG THE DIFFERENT SUB-AREAS. THE FOURTH TOPIC IS THE AGENCY MISSION OBJECTIVES AND RELEVANCE OF THE DIFFERENT SUB-AREAS. THE FINAL TOPIC RELATES TO THE GAPS AMONG THE AREAS WHICH ARE NOT ADDRESSED BY THE INVESTMENT STRATEGY. ALL OF THE ABOVE CRITERIA SHOULD BE AT A DESCRIPTIVE LEVEL

COMMENSURATE WITH THE SUB-AREA RESOLUTION. MORE DETAILED DESCRIPTIONS WILL BE PRESENTED BY THE SUB-AREA SPEAKERS.

THE LEVEL 3 SPEAKERS, EACH OF WHOM WILL COVER ONE SUB-AREA, WILL HAVE GUIDANCE SIMILAR IN FORM TO THAT OF THE LEVEL 2 SPEAKERS. THE MAJOR DIFFERENCE WILL BE IN THE LEVEL OF RESOLUTION OF DETAIL WHICH THE LEVEL 3 SPEAKERS WILL ADDRESS. THE LEVEL 3 SPEAKERS SHOULD BEGIN THEIR PRESENTATION BY RELATING THEIR OBJECTIVES TO THOSE COVERED IN THE LEVEL 2 SPEAKERS' PRESENTATION. THEN, THE LEVEL 3 SPEAKERS SHOULD PRESENT THE INVESTMENT STRATEGY FOR THEIR SUB-AREAS. THIS INVESTMENT STRATEGY INCLUDES THE ALLOCATION OF FUNDING WITHIN THE SUB-AREA, AND THE RATIONALE FOR THIS ALLOCATION. THE DOLLARS ALLOCATED SHOULD BE PRESENTED IN TABULAR FORM FOR FY9X - FY9Y, WITH FUNDS FOR SCIENCE AND TECHNOLOGY CATEGORIES BROKEN OUT. IT SHOULD PROVIDE SOME UNDERSTANDING OF THE PRIORITIZATION OF TASKS AND PROGRAMS WITHIN THE SUB-AREA. AS PART OF THE INVESTMENT STRATEGY, INTEGRATION WITH OTHER AGENCY, INDUSTRY, AND COUNTRY PROGRAMS AND PROJECTS SHOULD BE IDENTIFIED. THEN, THE S&T OBJECTIVES OF THE AREAS DISCUSSED SHOULD BE PRESENTED. THE COORDINATION AND INTEGRATION AMONG THE DIFFERENT PROGRAMS SHOULD BE ADDRESSED. AGENCY MISSION OBJECTIVES AND RELEVANCE OF THE DIFFERENT PROGRAMS SHOULD BE IDENTIFIED. THE S&T GAPS WHICH WERE NOT ADDRESSED BY THE INVESTMENT STRATEGY SHOULD BE DISCUSSED AND IDENTIFIED.

ONE OF THE KEY CHALLENGES IN THE PRESENTATIONS WILL BE TO SHOW THE CONNECTIVITY BETWEEN THE MORE FOCUSED TECHNOLOGY AREAS AND THE MORE FUNDAMENTAL GENERIC RESEARCH AND TECHNOLOGY AREAS. TO DISPLAY BOTH VERTICAL AND HORIZONTAL RESEARCH/TECHNOLOGY CONNECTIVITY, THE SUPPORTING SCIENCE AND TECHNOLOGY SPEAKERS WILL BE CROSS-REFERENCED DURING FOCUSED AREA PRESENTATIONS, AND WILL CROSS-REFERENCE EACH OTHER AS NECESSARY DURING SUPPORTING SCIENCE AND TECHNOLOGY PRESENTATIONS.

6) Importance of Dry Runs

THE DRY RUNS SHOULD BE ITERATED UNTIL THEY CONVERGE TO AN ACCEPTABLE PRODUCT.

TO FOSTER BETTER COORDINATION AND CROSS-REFERENCING AMONG THE SPEAKERS DURING VUGRAPH PREPARATION, ROUGH DRAFTS OF EACH DRY RUN SHOULD BE CIRCULATED TO ALL SPEAKERS A FEW WEEKS BEFORE DRY RUNS.

TO MINIMIZE EXCESSIVE TIME AT DRY RUNS, THE INTERMEDIATE OVERVIEW SPEAKERS SHOULD DRY RUN THE FOCUSSED AREA AND FUTURE OPTIONS SPEAKERS IN THEIR PURVIEW UNTIL SATISFIED. THEN THERE SHOULD BE FULL SPEAKER ATTENDANCE AT THE FINAL DRY RUNS FOR THE ASSESSMENT MANAGER. WELL BEFORE THE FULL ATTENDANCE DRY RUNS, THE OVERVIEW SPEAKERS SHOULD PRESENT "ESSENTIALLY FINAL" DRY RUNS FOR THE ASSESSMENT MANAGER.

7) Background Material

Maximum background material describing the research to be assessed, related research and technology development sponsored by external organizations, the organization, and other factors pertinent

to the assessment, should be provided to the reviewers as early as possible before the review. The will allow the reviewers and presenters to use their time most productively during.the review BY SUBSTITUTING DIALOGUE FOR MONOLOGUE. IT COULD POTENTIALLY REDUCE THE TOTAL REVIEW TIME AS WELL. FOR A VERTICALLY INTEGRATED STRUCTURE WHICH ENCOMPASSES A LARGE NUMBER OF PROGRAMS, REVIEW TIME BECOMES AN IMPORTANT CONSIDERATION FOR RETAINING THE AUDIENCE AND FOR AVAILABILITY OF HIGH QUALITY REVIEWERS. PROVISION OF THIS BACKGROUND MATERIAL ON FLOPPY DISKS, INCLUDING VUGRAPHS, SHOULD BE CONSIDERED TO REDUCE PAPER FLOW.

IN PARTICULAR, FOR EACH PROGRAM COVERED DURING THE ASSESSMENT, A WRITTEN SUMMARY SHOULD BE PROVIDED WHICH INCLUDES:

NAME, PHONE NUMBER, AND ORGANIZATION OF THE PROGRAM MANAGER,
TITLE OF PROGRAM
PROGRAM FUNDING FOR Z YEARS BY CATEGORY
DESCRIPTION OF TECHNICAL OBJECTIVES, CAPABILITY IMPROVEMENTS EXPECTED IF SUCCESSFUL, AND POTENTIAL PAYOFF TO AGENCY MISSION.

8) Final Presentations

THE PRESENTATIONS TO THE PANEL SHOULD BE DEVELOPED IN A SIMULTANEOUS ORDERLY "TOP-DOWN" AND "BOTTOM-UP" PROCESS. THE TOP LEVEL OVERVIEW SHOULD BE DEVELOPED FIRST, THEN THE NEXT LEVEL OVERVIEWS, AND FINALLY ITERATED WITH THE FOCUSSED PRESENTATIONS.

IN DEVELOPING THE OVERVIEW INVESTMENT STRATEGIES (AND THE FOCUSSED AREA STRATEGIES AS WELL), THE FOLLOWING SEQUENCE SHOULD BE USED. A PRIORITIZED SET OF MISSION REQUIREMENTS SHOULD BE GENERATED, THEN TRANSLATED INTO A SET OF PRIORITIZED S&T REQUIREMENTS. THE EXISTING AND PLANNED S&T PROGRAM WHICH IS DERIVED FROM THESE REQUIREMENTS SHOULD THEN BE IDENTIFIED. ITS MAIN COMPONENTS SHOULD BE PRIORITIZED. THE FUNDING ALLOCATION AMONG THESE COMPONENTS, AND THE RATIONALE FOR THIS ALLOCATION WHICH SUPPORTS THE PRIORITIZATION, SHOULD BE PROVIDED. OTHER AGENCY AND INDUSTRY FUNDING SHOULD BE TAKEN INTO ACCOUNT TO SHOW THE IMPACT OF LEVERAGING ON THE INVESTMENT STRATEGY.

ESTIMATES OF CAPABILITIES (QUANTITATIVE IF POSSIBLE) WHICH COULD RESULT FROM SUCCESSFUL TECHNOLOGY DEVELOPMENT SHOULD BE SPECIFIED, ALONG WITH ESTIMATES OF PRESENT CAPABILITIES, WITH SOME DESCRIPTION OF HOW THESE PROJECTED CAPABILITY ESTIMATES WERE OBTAINED.

FOR VERTICALLY INTEGRATED PROGRAMS, THE PRESENTATION SHOULD ALLOW THE PANEL TO IDENTIFY WHETHER THE DIFFERENT R&D CATEGORIES ARE UNDER COMMON OR DIFFERENT MANAGEMENT, IN ORDER TO DISTINGUISH MORE EASILY BETWEEN VERTICAL COORDINATION AND VERTICAL INTEGRATION. BACKGROUND MATERIAL COULD SUPPLY MUCH OF THIS INFORMATION.

PRESENTATIONS SHOULD FOCUS MORE ON THE COORDINATED AND INTEGRATED VERTICAL STRUCTURES THAN SPECIFIC R&D FUNDING CATEGORIES, AND SHOULD INCORPORATE MORE EQUALIZED REPRESENTATION FROM THE DIFFERENT FUNDING CATEGORIES IN PROGRAM PLANNING AND DEVELOPMENT OF THE PRESENTATIONS.

TO CLOSE THE LOOP ON LINKAGES BETWEEN THE SUPPORTING S&T AND MORE FOCUSSED AREA PRESENTATIONS, THE FOCUSSED AREA SPEAKERS SHOULD CROSS-REFERENCE THE SUPPORTING S&T SPEAKERS, AND VICE VERSA.

THE PRESENTATIONS SHOULD BE SHORT AND FOCUS ON KEY ISSUES AND THRUSTS. AN UPPER-LIMIT PERIOD OF AN HOUR, INCLUDING TIME FOR ANY QUESTIONS, FOR ANY PRESENTATION SHOULD BE ESTABLISHED.

FOR RELEVANCE ORIENTED REVIEWS, THERE NEEDS TO BE A CLEAN BREAK WITH THE TRADITIONAL PROGRAM REVIEWS, WITH THEIR EMPHASIS ON MONOLOGUE PRESENTATIONS OF DETAILED TECHNICAL MATERIAL. IF APPROPRIATE BACKGROUND MATERIAL IS SUPPLIED, INCLUDING VUGRAPHS, AND ONLY ESSENTIAL VUGRAPHS ARE PRESENTED DURING THE REVIEW, IT MAY BE POSSIBLE TO REDUCE THE LENGTH OF THE REVIEW BY DAYS. THIS WOULD AID IN EXPANDING THE POOL OF POTENTIAL REVIEWERS.

THE AGENCY COULD CONSIDER HOLDING THE RELEVANCE REVIEWS IN SOME RETREAT SETTING FOR THREE OR FOUR DAYS. WITH SUFFICIENT BACKGROUND MATERIAL SENT TO THE REVIEWERS, THE FOCUS OF THE REVIEWS WOULD BE ALMOST ENTIRELY ON DIALOGUE. PARTICIPANTS COULD BREAK OFF INTO SMALL GROUPS AFTER THE OFFICIAL DISCUSSIONS AND CONTINUE DIALOGUE IN A MORE INFORMAL MANNER TO CLEAR UP ANY OUTSTANDING ISSUES AND QUESTIONS.

VUGRAPHS WITH STANDARDIZED CONTENT SHOULD BE REQUIRED FROM THE PRESENTERS, CONTAINING THE FOLLOWING CRITERIA:

PRIORITIZED AGENCY MISSION REQUIREMENTS FOR SPECIFIC SUB-AREA TO BE PRESENTED,

PRIORITIZED S&T REQUIREMENTS,

INVESTMENT STRATEGY FOR MAIN SUB-AREA THRUSTS, INCLUDING THE FUNDING AND THE RATIONALE FOR EXISTING AND PLANNED PROGRAMS,

COORDINATION WITH OTHER RELATED PROGRAMS,

BROAD S&T OBJECTIVES FOR THE SUB-AREA,

S&T GAPS BASED ON REQUIREMENTS,

S&T OPPORTUNITIES,

POTENTIAL MULTIPLE APPLICATION PAYOFFS.

THE HIGHEST LEVEL OVERVIEW SHOULD BE THE MOST COMPREHENSIVE PRESENTATION IN IDENTIFYING SOURCES OF REQUIREMENTS.

9) Integrating Assessment Recommendations into Planning Cycle

Recommendations resulting from the assessment should be tracked to ensure that they are considered and implemented, where appropriate. For research programs, planning, execution, and review are linked intimately. Feedback from the review outcomes to planning for the next cycle should be tracked to ensure that the review/planning coupling is operable.

Attachment 6 - REVIEW PANEL SELECTION APPROACHES

A review panel should have at least the following characteristics:

1. Each member should be highly competent in the facet of the program for which he has been selected
2. The panel as a body should have sufficient competence to cover all major facets of the program being reviewed
3. Each member should be minimally conflicted with the program under review, and any conflicts or biases should be known to all the panel members before the review
4. Each member should agree to read all background material, attend all sessions, and protect any classified and proprietary information which arises during the review

Selection of an optimal review panel is more of an art than a science at present, and depends on the selector's understanding of the program being reviewed, on her understanding of the experts available in the technical community, and on her ability to predict the interaction dynamics of a particular group of experts. Presently, different Federal agency approaches in panel selection range from assembling program manager recommendations to using an iterative co-nomination approach. Since the latter approach, properly done, is relatively objective to the program being reviewed, the remainder of this attachment will focus on its description.

In essence, the iterative co-nomination approach is a multi-step process which starts with an input list of recommended experts and converges to a list of experts who have been multiply nominated by different experts. The first step is to define what specifically are the technical areas to be reviewed, and what is the objective and expected output of the review. Once the overall technical description of the program is generated, and technical descriptions of the subdisciplines are provided, reviewer identification can be initiated.

Sources of candidate reviewers can include program manager recommendations, membership lists of prestigous organizations such as the National Academies, agency review boards, agency consultant pools, and other similar lists. **(One of the real deficiencies in present day pools of reviewer candidates is the absence of a centralized updated pool of experts which spans the Federal agencies. With present computer capabilities, a centralized list which includes name, organization, biography, areas of expertise, previous panels and panel references for thousands of experts, and is easily accessible to assessment managers, would be simple to construct. It could be updated continuously with input from program managers as they become acquainted with new experts. Such a pool should be instituted immediately after multi-agency agreement.).** Multiple names are chosen to cover each sub-discipline, the program as a whole, allied research disciplines, the technologies, systems, and operations which the program could potentially impact, and other elements of the customer, stakeholder, user, and impactee

communities. This list of names is called level 1, or the initial list.

Each member of level 1 is asked to identify, or nominate, other experts in his particular area of expertise for the level 2 list. For example, assume that a Physics program is being assessed. Assume further that this program has three subdisciplines: plasma physics, atomic physics, and molecular physics. The level 1 list may have two names for each of the subdisciplines. To obtain the level 2 list for the plasma physics research area of expertise, each of the two plasma physics recommendees of level 1 would be asked to recommend two experts in plasma physics. If names appear more than once in the level 2 list, or between the level 1 and level 2 lists (multiply recommended individuals), then these people are assumed to be the leading experts in the fields to be assessed. If no multiple recommendations appear, then the experts in level 2 are asked to recommend two experts in plasma physics for level 3, and the co-nomination search is repeated. Convergence occurs when an adequate number of experts have been co-nominated. While this process may at first seem complex and open-ended, convergence is rapid because of the relatively small number of real experts in any well-defined technical discipline.

A primary and alternate list of co-nominees should be matrixed against selection requirements and criteria as shown below, where the matrix elements represent the reviewer's expertise in the different facets being examined. This matrix should be distributed to the program managers and performers who will be reviewed, and comments related to bias and conflict solicited. If strong objections can be supported, the list could be modified.

REVIEWER/ CRITERIA MATRIX

REV NAME/ORG	SUB- DIS1	SUB- DIS2	SUB- DIS3	TOTL PROG	TOT DEP	TECH EXPT	SYS EXP	PRI./ ALT
NAME.1.(OR1)	10	7	6	8	8	5	3	PRI.
NAME.2.(OR2)	9	9	5	9	9	4	2	ALT
NAME.3.(OR3)	6	8	10	7	7	7	5	PRI
NAME.4.(OR4)	5	4	3	4	4	10	8	PRI
NAME.5.(OR5)	2	2	3	3	3	8	10	PRI
NAME.6.(OR6)	7	8	7	7	8	6	5	PRI

Attachment 7 - ASSESSMENT ISSUES FOR PRESENTATIONS

CRITERIA FOR AGENCY REVIEWS

1. Quality and uniqueness of the work

2. Scientific and technological opportunities in areas of likely agency mission importance

3. Need to establish a balance between revolutionary and evolutionary work

4. Position of the work relative to the forefront of other efforts

5. Responsiveness to present and future agency mission requirements

6. Possibilities of follow-on programs in higher R&D categories

7. Appropriateness of the efforts for agency vice other agencies

8. A reliance (other agency coordination) connection of the work

QUESTIONS TO BE ASKED OF AGENCY PROGRAMS

1. What are we trying to do (in a systems concept)?

2. Can specific advantage to the agency be identified if program is successful?

3. How is the system done today and what are the limitations of the current practice?

4. Would the work be supported if it were not already underway?

5. Assuming success, what difference does it make to the user in a mission area content?

6. What is the technical content of the program and how does it fit with other ongoing efforts in academia, industry, agency labs, DoE labs, etc.?

7. What are the decision milestones of the program?

8. How long will the program take; how much will the program cost; what are the mid-term and final objectives of the program?

Attachment 8 - RESEARCH PRODUCT EVOLUTION TRACKING DATABASE

As stated previously, central to credible work in predicting and tracking the diffusion of information from research is a database of research products at various evolutionary stages which can feed the predictive models. This database of research products could be linked in part with the above-proposed database of research and technology. Since the research product evolutionary pathways transcend the research originating organization, and can intersect all societal sectors, the cooperation of many public and private organizations would be required to develop a database of research products in their evolutionary stages. Development and construction of such a database should start in the near future.

One approach to constructing this research product evolution database has its conceptual heritage in Kostoff [1994i]. The products of research and technology development programs would be entered into a database on a periodic basis. The research and technology product antecedents which led to these latest products would be identified. Linkages would be constructed to show the evolution of the research products over time, with appropriate credit given to the programs which spawned the initial research products.

As a particular example of an entry in the proposed database, assume that research program P1 has a number of products. These products could include papers, patents, reports, presentations, graduate students, etc. The various products would be entered into the database, and their ties with P1 and its input characteristics (evaluation scores, funding, etc.) would be retained. These products would be related to their antecedents, and these antecedents would be part of the database after the initial transient start-up period. For example, a paper which resulted from P1 would be linked through its references to research and development products (other papers, patents, presentations, etc.) resulting from other programs. A patent resulting from P1 would have similar linkages. For those products whose antecedent research and development products cannot be traced as easily as papers or patents (such as devices that are developed and not published in the literature), the program manager of P1 would enter the product and its antecedents in the database. In technology development and engineering development programs, there tends to be less of a readily available documentary trail of program products, and the program manager of these types of programs would have to supply more of the product and antecedent information than the nominal research program manager.

Included with the entry of an antecedent in the database would be some measure of its relative importance in the generation of the research product resulting from P1. Thus, for a patent which resulted from P1 and referred to five papers, some measure of importance of the impact of each of the five papers on the successful development of the patent of interest should be provided by the program manager. If providing an importance measure proves to be infeasible in practice because of sheer data volume limitations, then all antecedents could be assumed to have equal importance. Provision of an importance measure should not be ruled out at present, since

visionary approaches could conceivably overcome this problem.

Thus, in its steady state operation mode, the database would consist of large amounts of research and technology development products with quantitative measures of the strength of their linkages. If it were desired to examine the multiple impacts of a given research (or technology) program on downstream 'products', then the total output of the program could be integrated forward in time over the linkages. The downstream impact could then be related to the program inputs (evaluation scores, funding, etc.) to arrive at the desired information. Programs with little downstream impact would be identified as well as those with high downstream impact. If it were desired to start with a given downstream impact (say, a successfully developed system) and identify those research and development programs which contributed to successful development of the system (as well as the strength of their contribution) this could be done as well. The integration would be performed backwards in time over the linkages to arrive at the various research and technology development products which spawned the successful impact, and the research and technology development programs could then be identified from their products.

There may be other valid approaches to developing such a product tracking database, and at this early conceptual stage, all approaches should be considered. The most important factor is for government and private organizations to start serious planning of this database in the near future.

Attachment 9 - SAMPLE GUIDANCE FOR QUALITY/RELEVANCE PROGRAM REVIEW

9A. EXPANDED VERSION OF GUIDANCE

1. In the winter of CY95, the agency will conduct its annual series of Department Reviews at the program level. To introduce these reviews, each Department Director will provide an overview of that Department's total program, followed by a more detailed review of a portion (at least one third) of that Department's program. The purpose of the more detailed review of a portion of the program is to provide the means for examining the technical quality of the agency's research program. The intended audience includes: management, related technical-matter experts and integration partners from the agency; customer, stakeholder, user, and impactee personnel; and the external Science and Technology (S&T) communities. Specific objectives of the annual reviews include:

a. To identify the research investment, technical merit, and accomplishments of the science supported by the agency.

b. To assess the technical quality of and effectivity of science integration in the agency's programs in the context of the agency's investment plan.

c. To identify research program gaps and opportunities.

The FY95 reviews will give the agency's senior managers an opportunity to review the agency's research programs and to discuss program integration.

2. Department Heads should select and organize the more detailed review of the portion of their program into topical areas appropriate for achieving the stated objectives. One day should be allocated to each topical area, including an executive session at the end of each day as described below.

3. A panel of external reviewers (ER) will be used to help evaluate the research merit and relevance of programs in each topical area. In view of the diversity of topics which may be covered, ER membership may vary from day to day. ER tasking is provided in enclosure (1). ER members should include bench-level world-class technical experts, generalists with appropriate expertise to provide an independent assessment of research quality, and knowledgeable representatives from the agency's customer, stakeholder, and user community. Performers in the programs being reviewed will not be eligible, nor will anyone who has a financial or related conflict with the program being reviewed.

4. ER candidates should be submitted to the Director of Assessment. The submittal package should include a technical description of each sub-discipline to be reviewed, the candidates' names, organizations, biographies, sources of candidates names, and a matrix showing how the candidates' expertises relate to the areas being reviewed. The Director of Assessment will use the submitted names, as well as names

obtained from lists of members of the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, Federal agency advisory board members and consultants, and other sources of experts, as a starting point in the iterative co-nomination process to arrive at final reviewer selection. To provide continuity to the ER from year to year, ER members will receive staggered three year appointments.

5. Immediately after the scheduled daily presentations, the ER will meet in executive session to complete its program assessment task. The ER will meet with the Department Head and members of the Department during lunch to discuss the Department's programs. At the end of the day, the ER will meet with the agency's senior management to discuss the review.

6. The Department Reviews will be held as follows:

a. A tentative Department Review Schedule is provided. Department Heads will provide to agency senior management a detailed agenda one month prior to the scheduled presentation. This agenda will be used in the invitations for distribution by the Department Heads.

b. Department Heads will 'host' their Department's reviews, and will begin the first day with an approximately two hour overview of their program including 15 to 20 minutes for questions and discussions (following days will rely on the Read-Ahead packages and an abbreviated summary to fill in newly arrived reviewers). The remaining time will be used to present a more detailed review of a portion of the Department's program. Presentations will be given by the appropriate headquarters program officers, not by contractors or other performers. One quarter of each speaker's time slot should be reserved for questions and discussions. Dry runs of these presentations are strongly encouraged.

c. Agency senior management will be invited by the Department Head, who also should invite other persons who will contribute to or benefit from the review. For instance, these persons might include appropriate customers, stakeholders, users, impactees, other Federal agency managers and employees, and academic and industrial representatives as appropriate.

7. The Department Program will be evaluated using the criteria and questions in enclosure (2). A report summarizing the reviewers' comments on the Department Program and recommended action items is due to agency senior management 10 weeks after the Review. The senior management will prepare a formal list of follow-up actions required.

8. The philosophy, principles, structure, and goals of the Department Overview and the program reviews are as follows. The Overview presentation should show how the Department integrates into

the total organization, and how the Department's objectives relate to those of the agency. Then, the investment strategy of the Department should be presented in detail. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. (Later, for each program presentation, the investment strategy for its thrust areas should be presented.)

The investment strategy is perhaps the most crucial part of a Department and program review, and deserves further discussion here. While investment is the allocation of resources among the Department and program components, the investment strategy is the rationale for the prioritization and allocation of resources among the Department and program components. The optimal investment strategy for a Department and its programs is the focal point of the assessment, and is that allocation and rationale which will produce the most mission relevant high quality research for impacting the Department's and its program's objectives.

The optimal investment strategy results from a timely confluence of research requirements (top-down driven) and promising research opportunities (bottom-up driven). Further, promising research opportunities result from a timely confluence of advances in theory, instrumentation, new experiments, new algorithms, and computers. Finally, research requirements result from a timely confluence of domestic and foreign, political and economic, strategic and tactical advances. All of the above factors should be included in the presentation of the investment strategy.

While the emphasis is on peer review, bibliometric and other type of indicators should be utilized. It is recommended strongly that sufficient background material be supplied to the reviewers before the review. This would include organizational descriptive material, narrative descriptions of each program to be reviewed, and descriptive material of each work unit in the program. It would also prove useful to include bibliometric output indicators for each program, with interpretive analytical material. This could include refereed papers, patents, awards and honors, presentations, etc. It would be useful to include narrative material on related programs in other agencies and industry.

In particular, the following material should be presented. (In the interest of saving time, appropriate items may be included in the handout, and referred to, but not discussed. In such hand out material, amplifying statements, not bullets, should be provided.)

a. The Department's Overview should be just that, an overview of the entire Department's program including outside funding and a summary of related programs and funding at other agencies. The vugraphs of the Overview (enclosure 3) should be included in the handout but not necessarily discussed.

b. Indicate what has transitioned or is ready for transition.

c. New ideas, gaps and opportunities, failures, accomplishments, and future plans are the heart of this review.

d. Relevant programs managed by the agency for outside organizations should be included in the discussions.

e. Coordination of the Department program both within and outside the agency should be delineated. This should include discussion of how the program relates to other Federal agency programs, industrial programs, and international programs.

f. Discuss relevant comments from National Academy panels or other appropriate external review/advisory organizations that influence the program.

g. Each speaker in the more detailed review should present his/her investment strategy and address the relation of his/her program to the agency investment strategy.

9. A distribution of written hand-out material will be made as follows, with reference to the Timetable of enclosure (4):

a. A distribution of essential material, preferably by electronic means, to the reviewers at least 2 weeks prior to the review date. This material will include narrative descriptions of each program to be reviewed, narrative descriptions of each project within a given program, a list of performers and a summary of transitions, publications, patents, presentations, awards, and other relevant measures of program quality and impact.

b. The final Department Review hand-out package should include all Vugraphs and canonicals used in the Department Review, assembled in a coherent document for all attendees. Make the Vugraphs stand alone items with a title, properly labeled coordinates and a short descriptive text. Each vugraph must be dated. Updated program narrative descriptions for the more detailed portion of the program being reviewed.

c. The final Department Review hand-out package of essential materials, will be distributed 2 days before the review to the agency senior management. At least 20 copies should be available for distribution at the review.

10. A Department Review Report is due 10 weeks after the Review that includes:

a. List ER members and their affiliations.

b. ER comments and suggestions.

c. Major accomplishments/transitions with a sentence or two.

d. Program failures (inability to meet stated program objectives--not necessarily a sign of deficient performance), disappointments or phase outs/downs. These are inevitable in a program with an appropriate balance of high risk/high payoff projects.

e. Action Items. Written comments on Action Items should be completed by MAY 1995 for assembling in the final agency report of the FY94 Reviews.

EXTERNAL REVIEWER TASKING Enclosure 1

Preparation

1. Agree to the envisioned 3-year term as a ER member
2. Execute the conflict of interest form
3. Complete the appropriate travel forms
4. Digest the Read-Ahead package, including the Review Criteria

Program Assessment

Participate in the daily reviews, gaining the understanding necessary to apply the Review Criteria, to complete the review questionnaire, and to formulate measures of technical quality of the agency's research program. Discuss program content with agency senior management.

Daily outbrief

Discuss with agency senior management the effectiveness of briefings, addressing programmatic concerns and other issues.

Summary on-site findings

Participate in final daily outbrief, summarizing results to the extent possible.

Written report

Within 2 weeks of review completion, finalize findings and mail to agency.

Enclosure (2)

CRITERIA FOR AGENCY REVIEWS

1. Scientific quality and uniqueness of ongoing and proposed efforts

2. Scientific opportunities in areas of likely user importance

3. Balance between revolutionary and evolutionary research

4. Position of research relative to forefront of other scientific efforts

5. Responsiveness to present and future user requirements

6. Possibilities of follow-on programs in higher R&D categories

7. Appropriateness of research for agency vice other Federal agencies.

QUESTIONS FOR AGENCY PROGRAMS

1. What is the investment strategy of the larger management unit. This would include the relative program priorities, the actual investment allocation to the different programs, and the rationale for the investment allocation. For each program being reviewed, what is the investment strategy for its thrust areas.

2. Can specific advantage to customer be identified if program is successful?

3. Would efforts be supported if they were not already underway?

4. What is the technological context of the program and how does it fit with other ongoing research in academia, industry, and other Federal agencies?

5. Is the program appropriately coordinated with programs at other research organizations?

6. What are the research objectives of the program? What are the "mid term" and "final assessment criteria?" How much will the program cost?

7. What is the program trying to do?

8. How is the program (effort) done today? What are the limitations of the current practice?

9. What is new in the approach? Why will approach be successful?

10. What are the major risks of the program?

11. Assuming program is successful, what difference will the result make to customer capabilities?

Enclosure (3)

DEPARTMENT OVERVIEW

DEPARTMENT OBJECTIVE:

SCOPE OF PROGRAM:
(Statement of Science giving a useful taxonomy for the programmatic content)

Enclosure (3A)

DEPARTMENT OVERVIEW

TECHNICAL ISSUES:
(What are the major research issues currently being addressed by the Department covering the spectrum of the program?)

Enclosure (3B)

DEPARTMENT OVERVIEW

MAJOR RESEARCH ACCOMPLISHMENTS (IN PRIORITY):
(Do not make so concise as to unintelligible to the non-specialist. <u>Include these accomplishments in DEPTREV Report.</u>)

Enclosure (3C)
DEPARTMENT OVERVIEW

Department TRANSITIONS (in order of importance - list transition recipient, <u>summarize in the DEPTREV Report.</u>)

Enclosure (3D)

DEPARTMENT OVERVIEW

PLANS:
(Show how plans lead to major leap ahead capability. Show how program solved or helped solve a major problem. Where does it fit in the big picture?)

Enclosure (3E)

DEPARTMENT OVERVIEW

AGENCIES WITH SIMILAR OR ALLIED EFFORTS (ANNUAL $)
(Program similarities/differences. Where does the effort fit in the national research effort?)

Enclosure (3F)

<u>Include these sheets in DEPTREV Report.</u>

DEPARTMENT OVERVIEW FINANCIAL SUMMARY SHEET

	FY94	FY95	FY96	FY97
(Program/Project Title)	(Obligated and planned $)			

....

OTHER
Total FY94 $K spent
Number of FY94 tasks, #
Average FY94 task cost*, $K
Average FY93 task cost*, $K
New FY94 projects initiated, #
FY94 funds in new starts, $K
FY94 funds in new starts, %$

9B. ABRIDGED AND MODIFIED VERSION OF GUIDANCE

Sample Peer Review Guidance

A) Overall Objectives

1. Review 1/3 of organization's (Department, Division, Office, etc.) programs in depth each year; overview remainder of organization's programs; total organization program reviewed triennially.

2. Review vertically integrated programs as a unit.

3. Primary focus on technical quality, but address relevance, integration, and investment strategy as well.

4. Board of Visitors (BOV) provides comments on review. Written comments provided independently to agency staffer, who produces report. The BOV consists of independent experts representing science, technology, customer, and other agencies.

5. Invited review audience includes customers, stakeholders, users, impactees, and other agency representatives.

6. Summary report with responses to reviewers' comments and action items due to agency senior management after review.

B) Sequence of Events

1) Selection of Reviewers

A science and technology taxonomy of the program to be reviewed in detail is generated, and brief descriptors of each taxonomy element are generated for reviewer selection purposes. The BOV is selected so that it can address in aggregate detailed science and technology quality, research and technology gaps and opportunities, broader technology and organizational issues, and mission relevance issues. Sources of reviewers could include Defense Sciences Board, NAS, NAE, AFSAB, NSB, AAC (NASA), and program manager recommendations. The names of proposed reviewers are presented to the agency Director for approval before they are notified. All reviewers are required to sign non-conflict-of-interest statements.

2) Distribution of Background Material

To insure that review time is used most efficiently, reviewers and invited audience receive background material which will set the stage for the actual review. This background material includes the following administrative and technical canonical material:

a. Structural chart of agency, showing how organization fits into agency structure

b. Structural chart of organization, showing programs (including funding) and personnel associated with each program

c. Definitions of different generic types of programs which will be presented during review

d. Other administrative material (agenda, reimbursement, etc.)

e. Two page overview of each program being reviewed in detail (e.g. Weapons Technology), including program objective, program thrusts (e.g., Aerodynamics, Ordnance, G&C, etc.), and investment allocation among thrusts (three year trends)

f. Two page overview of each program thrust, including thrust objective and short descriptions of each technical sub-thrust (e.g., energetic propellants, combustion instability, propellant safety) pursued under the thrust as well as investment allocations among sub-thrusts. Total program and thrust descriptive material should not exceed twenty pages.

3) Senior Management Introductory Presentation

To initiate the actual review, a senior agency manager provides a short introduction describing structure and mission of the agency, the role of the different corporate review processes in executing the mission, and a more detailed description of the purpose and goals of Department review. This person describes what is expected from BOV, and how BOV comments will be utilized.

4) Organization Head Presentation

The broader technical portion of the presentations is initiated by the Organization Head, and it includes:

a. Mission and objectives of organization

b. List of all programs in organization; describe objectives of each program, show funds and people associated with each program; note program to be reviewed in detail

c. Accomplishments and transitions of programs not being reviewed in detail; relation of accomplishments and transitions to organization's mission and potential national impact

d. Responses to actions from previous year's review

5) Program Manager Presentation

Each program manager then provides a more detailed overview of the program, including:

a. Objectives of program

b. Requirements to be met (For example, in the review of a military-oriented program: what is the present and evolving threat-identify documented sources, personal contact sources, etc.; what is the importance of the threat; what are the capabilities required to overcome threat)

c. Investment strategy

c1. List of thrusts (e.g., Propulsion, Aerodynamics, G&C) and sub-thrusts (e.g., energetic propellants, combustion instability, propellant safety) selected to meet requirements

c2. Objectives of each thrust

c3. Thrust and sub-thrust funding and prioritization

c4. Rationale for thrust and sub-thrust selection and prioritization (including bases for rationale and prioitization such as system studies, workshops, assessments, intuition, congressional and other mandates, etc.)

c5. Integration of thrusts and sub-thrusts to form program

c6. Coordination/ Roadmaps

c6i. Roadmaps describe past, present, and future of program and linkage to other internal and external programs

c6ii. Roadmaps contain the three dimensions of time, project title/ sponsor, and project funding

d. Team quality (identify S&T performers)
e. Summary of major accomplishments, transitions, milestones met

6) Technical Manager Presentation

The technical managers who support the program manager will present the following:

a. Objectives of each sub-thrust
b. Technical roadblocks to achieving the sub-thrust objectives
c. Technical approach for overcoming the sub-thrust roadblocks
d. Potential sub-thrust payoffs and capability enhancements
e. Technical results achieved

7) Reviewers' Written Comments

The reviewers fill out an evaluation form, and provide it to the agency review manager at the end of the review. A sample short evaluation form follows.

PRESENTATION EVALUATION SHORT FORM

COMMENTS (PLEASE PROVIDE YOUR COMMENTS IN NARRATIVE FORM. WHERE APPLICABLE, INCLUDE YOUR ASSESSMENT OF RELEVANCE, GAPS AND OPPORTUNITIES, INVESTMENT STRATEGY, COORDINATION, TECHNICAL APPROACH, TEAM QUALITY, POTENTIAL PAYOFF, PRODUCTIVITY AND IMPACT. THESE EVALUATION CRITERIA HAVE BEEN DEFINED ON THE FIRST PAGE OF YOUR EVALUATION PACKAGE.)

Reviewers are invited to submit further written comments after they return home.

Attachment 10 - ESTIMATE OF PEER REVIEW COST

Another problem with peer review is cost. The true **total** costs of peer review, as will be shown, can be considerable but tend to be ignored or understated in most reported cases. Because there are many different types of peer review, it is very difficult to provide a total cost rule-of-thumb for generic peer review. Nevertheless, consider the following illustrative example for an <u>order of magnitude</u> estimate on total peer review costs.

Assume that an interim peer review is desired of a $1M/yr program at a laboratory. The review mode of operation will be to bring a panel of experts to the laboratory site for two days, and hear presentations from the principal investigators. Assume that the panel consists of ten experts in research, technology, mission operations, etc., and that eight principal investigators will present their projects to the panel. The loaded cost (salary plus overhead) for each panel member is assumed to be $150,000 per year, and the loaded cost for each principal investigator is assumed to be $125,000 per year. Direct expenditures, such as panel per diem and travel costs, would be in the neighborhood of $6,000-8,000. Any honoraria would increase this cost.

Indirect expenditures, such as total reviewer, presenter, staff, and review audience <u>time</u> spent toward the review, would be in the range of $125,000 and would include at least the following:

1. Presenter time in preparing background material for reviewers to read before review, preparing the presentation, making dry runs for management, etc. [$40,000 estimate; 80 person-days];
2. Panel member time for reading background material (papers, reports, plans), traveling to review, spending time at meeting, writing report, etc. [$48,000-60,000 estimate; 80-100 person-days];
3. Agency staff time for identifying and soliciting reviewers, establishing review and coordinating with lab, writing reports, etc. [$10,000 estimate; 20 person-days];
4. Audience (lab management, other lab personnel, other agency representatives, etc.) time at review [$20,000 estimate; 40 person-days].

The main conclusion of this discussion is that for serious panel-type peer reviews, where sufficient expertise is represented on the panels, <u>total real costs will dominate direct costs</u>. This conclusion would also be true for mail-type peer reviews. While the total costs of mail-type peer reviews would be less than those of panel-type peer reviews due to the absence of travel costs, the ratio of total costs to direct costs for mail-type peer reviews would be very high. The major contributor to total costs for either type of review is the time of all the players involved in executing the review. With high quality performers and reviewers, time costs are high, and the total review costs can be a non-negligible fraction of total program costs, especially for programs that are people intensive rather than hardware intensive.

Attachment 11 - DOE PROCEDURES FOR PEER REVIEW ASSESSMENTS

EXECUTIVE SUMMARY

PEER REVIEW ASSESSMENT PROCESS

The Office of Program Analysis (OPA) conducts peer review assessments of Department of Energy (DOE) research and development projects. The purpose of these reviews is to provide independent assessment of the quality and impact of each of the individual projects which comprise a program.

These reviews are carried out by five to nine scientific and technical experts who evaluate individual projects and provide their individual numeric ratings and commentary to OPA. OPA chooses the reviewers after obtaining recommendations from the research program managers and the principal investigators of the projects to be reviewed. OPA also conducts its own independent search for the best qualified candidates from academia, industry, Government laboratories, and other sources.

Presentations to the reviewers are made by program managers and principal investigators. After a question and answer period, which includes clarification of technical questions and a review of the evaluation criteria, reviewers prepare individual numeric ratings and commentary. An OPA staff member is present throughout the review process to ensure a uniform application of these procedures, that there is no attempt to reach consensus by the reviewers, and to receive the reviewers individual inputs.

PROCEDURES FOR PEER REVIEW ASSESSMENTS

Introduction

These assessment procedures provide the basis for implementing the methodology developed by the Office of Program Analysis (OPA) for assessing the quality and relevance of research and development within the Department of Energy (DOE). The reviews are performed by examining individual projects which comprise a program and by assessing the quality of the research, quality of the research team, productivity, probability of success, and mission relevance for each project reviewed.

OPA's methodology relies upon scientific and technical experts to evaluate individual projects. Analysis of the ratings given individual projects can contribute to the evaluation of a program.

Methodology

Reviewers are recruited in the specific technical area of a set of related research projects. Project reviews take place in sessions lasting from two to four days. Prior to the review meeting, a package of documentation covering the subject areas is requested from each Principal Investigator to help reviewers prepare for the review session. An outline of this documentation is provided in Appendix A, "Information to be Provided and

Presented by the Project Principal Investigator".

Because many of the projects are broad and multi-disciplinary, input from a broad range of experts is often necessary to perform the review. Every effort is made so that at least two of the reviewers are expert in the principal scientific disciplines or technical areas of each research project. Reviewers are drawn from academic institutions, industry, Government laboratories, and other sources, as appropriate.

OPA chooses reviewers after obtaining recommendations from the DOE program office, from the project principal investigators to be reviewed, and by an independent search for qualified candidates.

From its staff, OPA designates a Technical Project Officer to lead the assessment and staff members for each group of projects. The OPA staff member facilitates performance of the assessment and assists in completing the required tasks. The OPA staff member also ensures that the reviewers strictly adhere to these assessment procedures, including limiting discussions to exchanges of information.

The peer review focuses on the scientific and technological aspects and the mission relevance of the projects reviewed and not on budgetary or management issues. Reviewers evaluate the scientific and technical merit and quality of the research being performed under the current contract or grant, or in the case of a recent extension or continuation of the project to be reviewed, the immediately preceding contract or grant. The reviewers evaluate the most recent project performance, results, and products.

To begin, the reviewers meet in a plenary session. After welcoming remarks and an overview of the program being reviewed, a summary of the review process is presented, key staff personnel are introduced, and questions are answered. Reviewers then proceed to listen to the presentation of projects by the principal investigators.

Assessment of Projects

Prior to the appearance of the first principal investigator, a DOE program manager briefs the reviewers for up to 15 minutes on the set of projects to be reviewed. This overview, which can take the form of several briefings rather than one, orients the panel on the history, specific objectives, context within the DOE program area, and context within the field of the program area of each set of projects.

The principal investigator's 30 minute briefing emphasizes the scientific and technical aspects of the project, namely:

1. specific project objectives and how they relate to the DOE program's mission;
2. resources of time, special talents, and facilities used;
3. scientific and technical content of the project (issues being addressed and their significance and importance to the DOE program);
4. experimental and theoretical approaches; and
5. major recent accomplishments of the project together with

supporting data.

Principal investigators also inform reviewers of the identity of project staff and any collaborators, including their education, expertise, and role in the project, and the project's history showing DOE and non-DOE funding broken down by the periods of time in which the funding was received.

The principal investigator's oral briefing supplies the reviewers with sufficient information to evaluate the project using the factors, criteria, and formats given in Form 1. A list of topics to be included in the oral presentation is provided in Appendix A, "Information to be Provided and Presented by the Project Principal Investigator". While the documentation may complement the oral presentation, it does not supplant the requirement for a self-sufficient briefing to the reviewers by the Principal Investigator.

Reviewers independently assess the quality of the research, quality of the research team, productivity, mission relevance, and chooses an overall project rating using the factors, criteria, and formats given in Form 1. They also complete a Self-Rating Form (Form 2) for the project being rated. The self-rating form assists OPA staff in preparing their summary.

The assessment forms are followed precisely in performing the evaluation to ensure consistency of review for all projects. Any issues that arise regarding the meanings of the factors or criteria on the forms, or other matters requiring interpretation of these procedures, are resolved by the OPA staff.

Identification of Research Needs and Opportunities

Based on their knowledge of the needs of the program area, together with the newly acquired information pertaining to the nature and quality of DOE-funded projects in their areas of expertise, reviewers are asked to individually identify research needs and opportunities with respect to the DOE research program in the specific area of the panel review.

Assessment Summary

OPA staff, drawing upon individual contributions from reviewers, prepares an assessment summary. These contributions include all the numerical scores for each project accompanied by commentaries. Future needs for supporting research is also provided as commentary.

Instructions for Completing Project Rating Forms

Peer Review Questionnaire (Form 1)

Reviewers individually rate the project in each of six areas and choose an overall rating: scientific (technical) merit, importance of project, quality of project team, scientific (technical) approach, productivity, and probability of success. Ratings in these categories use a scale composed of integer values from zero to ten, with the ends of the scale representing seriously

deficient and outstanding attributes, respectively.

For Item Q1, "Scientific (Technical) Merit," reviewers assess the importance of the scientific (technical) question or problem addressed, including the potential importance or value to science (technology) of meeting the project objectives. This judgment is based primarily on the reviewer's knowledge of the scientific (technical) field.

In Item Q2, "Importance of Project," the reviewer is to assess the importance of the project's objectives in terms of contributing to the program's mission.

For Item Q3, "Quality of Project Team," reviewers consider the composition and quality of the team through examination of contributions by individual and associated team members relevant to the objectives of this project, honors and awards, experience relevant to the project area, and the balance of appropriate skills (including collaborators), for accomplishing the project objectives.

For Item Q4, "Scientific (Technical) Approach," reviewers consider the appropriateness of the experimental and analytical methods used and the level of insight and innovation demonstrated in relation to the requirements of the project's objectives.

For Item Q5, "Productivity," the reviewers consider the impact, volume, quality, and usefulness of work produced by the project team as a whole and relate this output to the resources available and costs incurred.

For Item Q6, "Probability of Success," reviewers assess the likelihood that the project will accomplish its stated objectives.

Overall Project Evaluation

The overall project evaluation score is a weighted judgment by the individual reviewer based on his/her experience and on the ratings given for Items Q1 to Q6. It is not mathematically derived from the factor scores. Criteria for choosing an overall project evaluation are also on Form 1.

Responsibilities of Participants

Instructions for Reviewers

Reviewers are the key participants in the peer review assessment. They have the following responsibilities:

Become familiar with the peer review assessment procedures before review of the first project. This includes: (a) reviewing the "Procedures for Peer Review Assessments" document, which is provided prior to the review session; (b) attending the plenary session at the start of the review for an overview of the process and a presentation of mission of the program whose projects are to be reviewed; and (c) following the detailed instructions given by the OPA staff.

Prior to each project's review, read the pre-presentation package of information provided by the principal investigator.

Participate in the review of every project of the group

assigned. Listen to the principal investigator's oral presentation and, in turn, ask pertinent questions to obtain the information needed to answer the rating factors of the questionnaire forms.

Reviewers clarify technical points and rating criteria as necessary.

Reviewers independently complete a set of rating forms on the project presented. The reviewers use the standard factors, and criteria provided on the forms, and provide brief supporting written comments.

Following project evaluations, the reviewers independently identify research needs or opportunities in the technical area of the group's projects.

Instructions for Principal Investigators

Principal investigators provide five types of information to facilitate review of their research:

1. statement of current project objectives, and an abstract of the project;
2. recommendations of expert reviewers for their project;
3. notification that the project does or does not contain privileged or protected information;
4. a package of documentation describing the project; and
5. an oral presentation to the reviewers at the group session.

The project abstract, recommendation of expert reviewers and notification of whether or not the project contains privileged or protected information is forwarded to the Technical Project Officer by the Principal Investigator immediately upon receipt of notification of the project review.

In the pre-review session package, principal investigators provide information describing the project relevant to the rating factors and criteria on Form 1. No privileged or unprotected information is included. This package helps the reviewers prepare to hear the upcoming oral presentation. The Technical Project Officer, or his/her designee, collects the documentation from the principal investigator and forwards copies to the appropriate reviewers, OPA staff, and DOE Program Managers. Contents of the package are described in Appendix A.

Appendix A also lists the items to be included in the Principal Investigator's oral briefing to the reviewers. Items 5A (specific project objectives), 5B (how the project relates to the DOE program's mission), 6 (scientific and technical content), and 7 (recent project output) are stressed in the oral presentation. Conversely, Items 1, 3, 4, 5C, and 5D in Appendix A (principal project personnel, additional project personnel, project history, and how the project relates to others being funded by the DOE program) are quickly covered in one or two slides or by handout material.

Investigators supply 12 copies of any reprints, documents, or material provided to the reviewers. This applies to both the package of documentation and visual aids used during the Principal

Investigator's oral presentation. The copies of the visual aids are provided to the reviewers at the start of the oral presentation.

Reviewers expect the oral presentations to primarily deal with the technical content and output of the project, and to provide supporting data. Reviewers base their individual evaluations of a project primarily on the oral presentation made by the Principal Investigator and on his or her responses to questions. While the package of documentation may complement the oral presentation, it does not supplant the requirement for a self-sufficient briefing to the reviewers by the Principal Investigator.

Instructions for DOE Program Managers

The Program Managers from DOE Headquarters, or DOE Field Offices, have an important role in helping reviewers to understand the importance and significance of the research being reviewed.

The briefing during the plenary session (up to 20 minutes) includes:

1. statement of interest in review and intended use of results;
2. overview of program, including background, contents, scope, timing, and relationship of subparts; and
3. official program mission statement from approved planning document. (Plan to leave copies of the statement for use by reviewers.)

To prepare reviewers to assess the projects brought before them in the proper context, the Program Manager presents (for up to 15 minutes) the following:

1. definition of subprogram area(s) represented by projects to be reviewed;
2. goals of these subprogram areas related to the official program mission statement;
3. how each project to be reviewed supports subprogram goals;
4. relation to other projects (not assessed by these reviewers) that also support these goals; and
5. pertinent history, accomplishments, and plans for the subprogram.

The introductory briefing for each project (up to 5 minutes) covers:

1. relation of project objectives to subprogram goals and official program mission, and benefits expected if project is successful;
2. summary of funding and performance dates; and
3. introduction of the Principal Investigator and any observers to the presentation.

Program Managers also ensure that project objectives provided by the Principal Investigator represent the Program's full expectations for that project. The objectives presented by the Principal Investigator are the basis used by the reviewers to perform their evaluation of the research.

NONDISCLOSURE OF PRIVILEGED OR PROTECTED INFORMATION

Principal Investigators are encouraged to exclude privileged or protected information from their presentation, whenever possible.

Under current law (the Dole-Bayh Act, 35 USC Sect. 200, et seq.), universities, nonprofit organizations, and small businesses have the right to retain the title to any inventions made under a Government-funded contract or grant. At the same time, it is a Department of Energy (DOE) goal to have projects assessed by the most competent persons available.

Where it is determined to evaluate a project falling under the purview of the Dole-Bayh Act using persons from outside the Government, such as consultants, grantees, and contractors, each reviewer must sign a nondisclosure agreement before receiving access to information in which a university, nonprofit organization, or small business claims to have a proprietary interest or claims is confidential. The nondisclosure agreement is shown on Appendix B. It has been approved by Department of Energy's Office of General Counsel.

The Department of Energy cannot guarantee the maintenance of absolute secrecy in the handling of privileged information presented by the Principal Investigators. Consequently, the Principal Investigators are discouraged from providing such information in their oral presentations. However, when the presentation of privileged information is essential to provide a complete understanding of the project's research by the reviewers, DOE will make every attempt to protect the confidentiality of presented privileged information in accordance with existing laws and regulations.

The Principal Investigator is to alert the Technical Project Officer (Appendix A, Item II) and the reviewers if information, data, or material requiring protection is to be included in the oral presentation. Such information is not to be included in the package of documentation on the project. The Principal Investigator is not to provide any privileged information in copies of oral presentation visual aids to be given to the reviewers.

The reviewers and OPA staff are alerted to the presentation of privileged or protected information by: (1) a statement by the Principal Investigator at the beginning of his or her oral presentation, and (2) at the time the specific privileged information is provided in the oral presentation.

PROJECT RATING FORMS

FORM 1 Reviewer

____

Panel/Project: ______________________ Date of Review: ________

PEER REVIEW QUESTIONNAIRE

Q1. Scientific or Technical Merit of the Project Objectives

0 1 2 3 4 5 6 7 8 9 10

Project objectives of central importance to advancing the science, technology, discipline, or research area rate 9-10, project objectives that address significant issues rate 7-8, project objectives providing information of general usefulness and interest rate 5-6, Routine project objectives rate 3-4, and project objectives of doubtful or peripheral interest would rate 0-2. Circle the appropriate number for your rating.

Supporting Comments:

Q2. Importance of Project Objectives to Mission

State your estimate of the importance of this project's stated objectives in terms of contributing to the program's stated mission. Circle the appropriate number for your rating.

Not Important Very Important

0 1 2 3 4 5 6 7 8 9 10

Supporting Comments:

Q3. Quality of Project Team

0 1 2 3 4 5 6 7 8 9 10

An outstanding team rates 9-10, a strong, balanced team of experienced investigators rates 7-8, a good team that would benefit from additional skills rates 5-6, a team that requires strengthening rates 3-4, and a team with serious shortcomings rates 0-2.

Supporting Comments:

Q4. Scientific or Technical Approach

0 1 2 3 4 5 6 7 8 9 10

An expert and innovative approach rates 9-10, a skillful and logical approach rates 7-8, a reasonable approach with potential for improvement rates 5-6, an approach with key shortcomings or an approach that is out-of-date rates 3-4, and an inappropriate or illogical approach rates 0-2. Circle the appropriate number for your rating.

Supporting Comments:

Q5. Productivity

0 1 2 3 4 5 6 7 8 9 10

With respect to the resources available: 9-10 indicates high impact, exceptional output, 7-8 indicates significant results at an extensive rate, 5-6 indicates interesting results at a reasonable rate, 3-4 indicates marginal output, and 0-2 denotes little evidence of progress. Circle the appropriate number for your rating. If the project has not been under way long enough to be rated for productivity, so state.

Supporting Comments:

Q6. Probability of Success

State your estimate of the probability of success of this project accomplishing its stated objectives. Circle the appropriate number for your rating.

Low High

0 1 2 3 4 5 6 7 8 9 10

Supporting Comments:

OVERALL PROJECT EVALUATION

0 1 2 3 4 5 6 7 8 9 10

An outstanding project rates 9-10. A strong project deserving of priority continuation rates 7-8, while a good project, deserving of continuation, that may have some shortcomings which can be addressed by the Principal Investigator rates 5-6. A weak project, or one with some deficiencies requiring program management

attention rates 3-4, and a poor project with serious deficiencies which warrants close reevaluation by program management rates 0-2. Circle the appropriate number for your rating.

Supporting Comments:

FORM 2

Reviewer # _______

Panel/Project: ____________________ Date of Review: ______________

REVIEWER SELF-RATING

1. Please rate your knowledge in the scientific/technical research area or discipline covered in this project.

Novice			Understand			Knowledgeable				Expert
0	1	2	3	4	5	6	7	8	9	10

Appendix A

INFORMATION TO BE PROVIDED AND PRESENTED BY THE PROJECT PRINCIPAL INVESTIGATOR

1) Abstract (one page maximum)

Project Title: The title should describe the current project effort, especially for projects that may have been renewed.

Objective(s): in priority order, and why are you doing this?

Body of abstract which describes the research project, and particularly the technical approach.

Project Performance Period:

Project Funding:

Principal Investigator(s): Name(s), Mailing Address, Phone Number, FAX number, E-mail address.

Principal Investigator(s) Organization:

DOE Program Manager:

Please return this form to Technical Project Officer, ER-XXX. E-mail is preferred in ASCII format. Fax an additional copy to FAX 301-903-5561 (or 3888) as backup.

2. Patentable or Potentially Patentable Inventions

<u>Principal Investigators are encouraged to exclude patentable, unpublished, and unfiled information, whenever possible.</u>

Under current law (the Dole-Bayh Act, 35 USC Sect. 200, <u>et seq.</u>), universities, nonprofit organizations, and small businesses have the right to retain the title to any inventions made under a Government-funded contract or grant. At the same time, it is the Department of Energy's goal to have projects assessed by the most competent persons available. Where it is determined to evaluate a project falling under the purview of this law, using persons from outside the Government, such as consultants, grantees, and contractors, a nondisclosure agreement or an equivalent arrangement is needed before protected or privileged information can be released to such evaluators.

If the information to be presented requires protection under the Dole-Bayh Act, 35 USC Sect. 200, <u>et seq.</u>, include and sign the following statement:

"I am an owner, officer, or employee of a university, not-for-profit organization, or small business, and the information to be presented will contain information, data, or material pertaining to an invention, or inventions, made under a Government-funded contract grant that I believe is potentially patentable."

____

Signature

Otherwise, indicate not applicable on the signature line.

Ten Page Research Summary

(Limit to 10 pages)

1. Project Title
   Principal Investigator:
   Organization:
   Address:
   Telephone Number(s):

2. Principal Project Personnel
   Identify the important technical contributors to the project, including the Principal Investigator, and provide the following information for each:

   A. Role in the project.
   B. Principal areas of research and expertise.
   C. An indication of the percentage of time, or annual hours, each devotes to the project.
   D. Education.

E. Relevant professional employment history, including a list of the institutions, dates employed, and positions held.

F. Relevant professional activities and honors.. This could include professional society activities, awards and prizes, patents, advisory committee assignments, Congressional testimony, or any other activities which reflect on standing within the research community.

G. Relevant publications not emanating from this project. <u>(Do not include extensive lists of publications of little relevance to the project being evaluated.)</u>

3. Additional Project Personnel

A. For other members of the technical staff: name, education, principal areas of research and expertise, and role in the project.

B. For collaborators on the project: name, institution, position, education, principal areas of research and expertise, and role in the project.

4. Project Overview

A. Specific Project Objectives

1) Past (if project is a continuation or extension of earlier work or a follow-on building on earlier successes).

2) Current (the project is to be measured only against the current objectives.)

3) Planned future work on this project.

B. How this project relates to the DOE program's mission.

C. How this project relates to other projects being funded by DOE (to the extent this is known by the Principal Investigator).

D. Project History

1) Previous and current funding (broken out to identify direct research funding and overhead, list DOE and non-DOE separately).

2) Previous and current contracts or grants and their beginning and ending dates.

5. Scientific and Technical Content

A. Relation of this research to research being conducted by others in this field.

B. Importance of solving the problem being addressed by this research.

C. Schedule of major research activities.

D. Scientific or technical issues currently being addressed and their significance.

E. Experimental and theoretical approach taken, techniques used, and resources applied.

6. Project Output

Information relative to the project output which includes at least the following:

A. Major recent accomplishments with supporting data and their significance (only those products or results under the current contract or grant).

B. Bibliography of publications emanating from this project. From the bibliography, select no more than five of the most recent, significant publications in the professional or scientific literature and submit 12 copies, or reprints, of each.

7. Oral Presentation

Key points for a Principal Investigator when preparing an oral briefing:

A. Privileged or protected information should be presented only at the oral presentation; then only if absolutely necessary. No privileged or protected information is to be included in the pre-review session package of information describing the project.

B. Special presentation needs should be specified in advance; otherwise, presentation rooms will be equipped with one overhead projector, one 35 millimeter slide projector, and an easel for writing or drawing.

C. Investigators supply 12 copies of any reprints, documents, or material to be provided to the reviewers. Exclude privileged information from the handouts. Presenters should hand out 12 hard copies of their presentation aids to the reviewers at the time of their presentation.

D. List all of the project's objectives, indicate the percentage resources allocated to each objective, and show the current status toward fulfillment of each objective. State the scientific importance and relevance of these objectives to the DOE program's mission.

E. Emphasize technical approaches, recent work, and recent progress and accomplishments. In doing so, present data, charts, equations, photographs, or other commonly recognized proof of results.

F. Discuss work performed on earlier contracts or on parallel non-DOE contracts only as needed to set the stage for the current project. Generally, spend no more than five minutes on earlier work. Clearly identify work not performed on the current project.

Appendix B

U. S. DEPARTMENT OF ENERGY

(PROGRAM AREA)

PEER REVIEW NONDISCLOSURE AGREEMENT

I agree to use the information revealed during review of the project.

---

only for Department of Energy (DOE) assessment purposes and to treat the information which may be confidential in nature in confidence. **The specific type of information considered proprietary is:**

If in the course of this project review, I do acquire or have access to any information, data, or material which is business confidential, proprietary, or otherwise privileged, and is so indicated in writing, I agree that such information will not be divulged to any person or any organization or utilized for my own private purposes or in any manner whatsoever, other than in the performance of this project review:

1. without the prior written permission of the disclosing party or the_ contracting officer for the work being evaluated, or
2. until such information, data, or material is first publicly disseminated by the DOE or its contractor or grantee performing the work, or
3. is or becomes known to the public from a source other than me, or
4. is already known to me or my employer as shown by prior records, whichever event shall first occur.

____

(Signature)

____

(Name)

Printed or Typed

____

(Date) DOE,"

Attachment 12 - EVALUATION FORMS FOR EXISTING PROGRAMS - LONG FORM

TITLE OF PROGRAM...
REVIEWER NAME..
....
1A. RESEARCH MERIT (CIRCLE ONE NUMBER OR -)
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1B. RESEARCH APPROACH/ PLAN/ FOCUS/ COORDINATION
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1C. MATCH BETWEEN RESOURCES AND OBJECTIVES
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1D. QUALITY OF RESEARCH PERFORMERS
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1E. PROBABILITY OF ACHIEVING RESEARCH OBJECTIVES
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1F. PROGRAM PRODUCTIVITY
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2A. POTENTIAL IMPACT ON MISSION NEEDS (RES/ TECH/ OPERATIONS)
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2B. PROBABILITY OF ACHIEVING POTENTIAL IMPACT ON MISSION NEEDS
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2C. POTENTIAL FOR TRANSITION OR UTILITY
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2D. PHASE OF R&D (DOD TERMINOLOGY)
6.1----------------------6.2-----------------------6.3
BASIC RES** *APPLIED RES** **EXPLORATORY DEV.* *ADV DEV*
....
3. REVIEWER'S EXPERTISE IN THE RESEARCH AREA OF THIS PROGRAM
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
4. O V E R A L L   P R O G R A M   E V A L U A T I O N
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**

Attachment 13 - EVALUATION CRITERIA FOR EXISTING PROGRAMS

SCORING CRITERIA

The evaluation form contains factors generally related to research and naval relevance issues. The scoring bands for all criteria except 2D are identical, and are: 1-2 (LOW); 2.5-4 (FAIR); 4.5-6.5 (AVERAGE); 7-8.5 (GOOD); 9-10 (HIGH). Criterion 2D has its own scoring range defined.

DEFINITIONS OF CRITERIA ON PROGRAM EVALUATION FORM

1A. RESEARCH MERIT - Importance to the advancement of science of thequestion or problem addressed by the program. Consider the technical objectives, potential advancement of state-of-art, and uniqueness ofcontribution.

1B. RESEARCH APPROACH/ PLAN/ FOCUS/ COORDINATION - Quality of process employed to solve the research problem, including the quality and focus of the research plan, definition of research milestones, degree ofinnovation, understanding of field, balance between experiment and theory, and coordination with (or cognizance of) other related programs to minimize duplication or gaps.

1C. MATCH BETWEEN RESOURCES AND OBJECTIVES - Relationship between scientific objectives proposed and total resources requested. Also, adequacy of resources at performer level to ensure 'critical mass' for each performing unit.

1D. QUALITY OF RESEARCH PERFORMERS - Consider publications, honors, and awards, relevant experience, and other less tangible factors which contribute to team quality.

1E. PROBABILITY OF ACHIEVING RESEARCH OBJECTIVES - Probability that the program's research objectives will be achieved.

1F. PROGRAM PRODUCTIVITY - Volume and quality of work produced and relationship of this output to the resources available, costs incurred, and time elapsed since program initiation.

2A. POTENTIAL IMPACT ON MISSION NEEDS - Potential impact of this program on mission research/ technology/ operational needs if successful.

2B. PROBABILITY OF ACHIEVING POTENTIAL IMPACT ON MISSION NEEDS - Probability that the program will achieve its potential mission impact assuming that its research objectives have been met.

2C. POTENTIAL FOR TRANSITION OR UTILITY - Probability that results from this program will be transitioned to or utilized by technical community assuming that its research objectives have been met.

2D. PHASE OF R&D - Level of program development. Scale ranges from basic research (6.1) through exploratory development (6.2) to advanced development (6.3).

4. OVERALL PROGRAM EVALUATION - Single number description of overall program quality based on all relevant criteria. Provide detailed narrative of pros and cons and any recommendations under COMMENTS.

Attachment 14 - EVALUATION FORMS FOR PROPOSED PROGRAMS - LONG FORM

TITLE OF PROPOSED PROGRAM..
REVIEWER NAME..
....
1A. RESEARCH MERIT (CIRCLE ONE NUMBER OR -)
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1B. RESEARCH APPROACH/ PLAN/ FOCUS/ COORDINATION
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1C. MATCH BETWEEN RESOURCES AND OBJECTIVES
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1D. BALANCE BETWEEN EXPERIMENT AND THEORY
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
1E. PROBABILITY OF ACHIEVING RESEARCH OBJECTIVES
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2A. MISSION NEED (PROB OR NEED WHICH THIS RESEARCH ADDRESSES)

....
2B. POTENTIAL IMPACT ON MISSION NEEDS (RES/ TECH/OPERATIONS)
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2C. PROBABILITY OF ACHIEVING POTENTIAL IMPACT ON MISSION NEEDS
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2D. POTENTIAL FOR TRANSITION OR UTILITY
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
2E. PHASE OF R&D (DOD TERMINOLOGY)
6.1----------------------6.2-----------------------6.3
BASIC RES** *APPLIED RES** **EXPLORATORY DEV.* *ADV DEV*
....
3. REVIEWER'S EXPERTISE IN THE RESEARCH AREA OF THIS PROGRAM
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**
....
4. O V E R A L L   P R O G R A M   E V A L U A T I O N
1-----2-----3-----4-----5-----6-----7-----8-----9-----10
LOW** ***FAIR ***AVERAGE**** ****GOOD**** **HIGH**

Attachment 15 - EVALUATION CRITERIA FOR PROPOSED PROGRAMS

SCORING CRITERIA

The evaluation form contains factors generally related to research and mission relevance issues. The scoring bands for all criteria except 2A and 2D are identical, and are: 1-2 (LOW); 2.5-4 (FAIR); 4.5-6.5 (AVERAGE); 7-8.5 (GOOD); 9-10 (HIGH). Criterion 2A has no scoring range, and criterion 2E has its own scoring range defined.

DEFINITIONS OF CRITERIA ON PROPOSED PROGRAM EVALUATION FORM

1A. RESEARCH MERIT - Importance to the advancement of science of the question or problem addressed by the program. Consider the technical objectives, potential advancement of state-of-art, and uniqueness of contribution.

1B. RESEARCH APPROACH/ PLAN/ FOCUS/ COORDINATION - Quality of process employed to solve the research problem, including the quality and focus of the research plan, definition of research milestones, degree of innovation, understanding of field, and coordination with (or cognizance of) other related programs to minimize duplication or gaps.

1C. MATCH BETWEEN RESOURCES AND OBJECTIVES - Relationship between scientific objectives proposed and total resources requested.

1D. BALANCE BETWEEN EXPERIMENT AND THEORY - Balance between experiment and theory proposed relative to optimum required to achieve performance targets.

1E. PROBABILITY OF ACHIEVING RESEARCH OBJECTIVES - Probability that the program's research objectives will be achieved.

2A. MISSION NEED - Identify the mission need or problem (operational, technological, research) to which this research relates.

2B. POTENTIAL IMPACT ON MISSION NEEDS - Potential impact of this program on mission research/ technology/ operational needs if successful.

2C. PROBABILITY OF ACHIEVING POTENTIAL IMPACT ON MISSION NEEDS - Probability that the program will achieve its potential mission impact assuming that its research objectives have been met.

2D. POTENTIAL FOR TRANSITION OR UTILITY - Probability that results from this program will be transitioned to or utilized by technical community assuming that its research objectives have been met.

2E. PHASE OF R&D - Level of program development. Scale ranges from basic research (6.1) through exploratory development (6.2) to advanced development (6.3).

4. OVERALL PROGRAM EVALUATION - Single number description of overall program quality based on all relevant criteria. Provide detailednarrative of pros and cons and any recommendations under COMMENTS.

Attachment 16 - IDENTIFYING KEY REVIEWER CRITERIA

Background

During the 1980s, a competitive process among all of ONR's claimants was used to select new Accelerated Research Initiatives (ARIs). In the mid to late 1980s, panels of experts external to ONR were used to evaluate these proposed ARIs (Research Options - ROs). From 1986-1990, 105 ROs were evaluated, and the factors which the reviewers evaluated and scored for each RO remained essentially the same. In 1990, the following analysis was made of the reviewers' scores.

Purpose

1. It was decided to analyze the patterns of the scores of these 105 ROs. This analysis would have the following benefits:

2. Future ROs could be improved through the feedback of observed trends and patterns to the proposers

3. The evaluation questionnaire could be simplified if some of the factors proved to be unimportant in determining the final score

4. The review process could be altered if different factors were important for different claimants or for different technical areas

5. The development categories (early 6.1 [6.1 is DOD terminology for basic research], late 6.1, etc.) of different claimants' ROs could be checked against the claimants' charters to determine whether these charters were being followed

Overview of Contents

The present document contains an analysis of the panel reviewers' scores. Categorizations of the data base are made to allow parametric studies. The first section of this report contains regressions and correlations of the scoring factors as a function of claimant, winners/losers, technical discipline, single/multi, size, and Phase of R&D (development category). The purpose of this first section is to identify which factors were important to the reviewers in determining their final score for each RO, and whether these key factors change for different parametric values. The second section of this report contains plots of dollars vs Phase of R&D, as a function of claimant, POM year, technical discipline, RO size, number of claimants proposing the RO, and winners/ losers. The third section of this report contains plots of dollars vs Overall Program Score (OPE - the reviewers' bottom line score), as a function of the same parameters as above.

1. REGRESSION ANALYSIS RESULTS

The factors from the reviewers' questionnaires which are used in the regression analyses are: Research Merit (RM); Research Approach (RA); Match Between Resources and Objectives (MBRO); Balance Between Experiment and Theory (BBET); Potential Impact on Naval Needs (PINN);

Potential for Transition or Utility (PTU); Overall Program Evaluation score (OPE); and Phase of R&D (in DOD terminology, research and development category). For the main regression analysis, fifteen different parametric variations were made with the seven factors RM, RA, MBRO, BBET, PINN, PTU, OPE, and one run was made to show intercorrelations among these seven evaluation factors for the total data base. The same type of analysis was performed in each of the fifteen runs.

First, a six factor model was obtained from the multiple regression analysis to predict OPE: (OPE=b0+b1*RM+b2*RA+b3*MBRO +b4*BBET+b5*PINN+b6*PTU). The three independent variables (x1, x2, x3) with the highest regression coefficients (b1, b2, b3) were then used in a three factor model (OPE=b0+b1*x1+b2*x2+b3*x3), and the resultant R-Squared values (R-Squared represents the fraction of the total variability removed by the regression) were compared to determine the effectiveness of a three factor model relative to a six factor model. After the highest R-Squared three factor model was run, the independent variables (x1, x2) with the two highest regression coefficients (b1, b2) were used in a two factor model (OPE=b0+b1*x1+b2*x2). The process was repeated again going to a one factor model (OPE=b0+b1*x1).

In addition to the fifteen cases mentioned above, seven other regressions were run. OPE score was regressed against RO size (where size is the amount of funds requested for the RO's first year) for all ONR, CRP (an ONR unit at the time), and non-CRP; and OPE score was regressed against Phase of R&D for all ONR, CRP, and non-CRP. CRP Physical Sciences ROs were analyzed similarly to the fifteen cases above.

The results of the first fifteen cases are summarized in Table 1 below. Starting from the left-hand side, the first column describes the subdivision of the total RO data base to which the regression applies. The second column contains the value of R-Squared for the six factor model. The third, fourth, and fifth columns contain the three evaluation factors which produce the highest value of R-Squared of any three factor model. These three factors always had the highest regression coefficients in the six factor model, and these factors are shown from left to right in order of descending magnitude of their regression coefficients. The sixth column contains the value of R-Squared for the model which consists of the factors contained in the previous three columns. The seventh and eighth columns contain the two evaluation factors which produce the highest value of R-Squared of any two factor model. These two factors are shown from left to right in order of descending magnitude of their regression coefficients. The ninth column contains the value of R-Squared for the model which consists of the factors contained in the previous two columns. The tenth column contains the evaluation factor which produced the highest value of R-Squared of any one factor model. The eleventh column contains the value of R-Squared for this one factor model.

TABLE 1

SUMMARY OF REGRESSION RESULTS

1	2	3	4	5	6	7	8	9	10	11
	6		3			2			1	
	FAC		FAC			FAC			FAC	
	MOD		MOD			MOD			MOD	
CASE	R^2	FACTORS			R^2	FACTORS		R^2	FACT	R^2
ALL ONR	.903	RM	PTU	RA	.901	RM	PTU	.871	RM	.783
ALL WINNING	.866	RM	RA	PTU	.863	RM	PTU	.824	RM	.703
ALL LOSING	.775	PTU	RM	RA	.768	RM	PTU	.741	RM	.561
PHYS SCI	.899	RM	BBET	RA	.888	RM	RA	.869	RM	.779
ENV SCI	.914	RM	MBRO	PTU	.904	RM	MBRO	.897	RM	.840
ENG SCI	.971	PTU	RM	RA	.960	PTU	RM	.953	RM	.729
LIFE SCI	.962	RM	PTU	RA	.936	RM	PTU	.919	RM	.824
CRP	.892	RM	RA	PTU	.889	RM	RA	.865	RM	.777
NRL	.885	BBET	RM	RA	.874	BBET	RM	.860	BBET	.774
NON-CRP	.915	RM	PTU	BBET	.904	RM	PTU	.891	RM	.782
SINGLE CLAIM	.899	RM	PTU	RA	.897	RM	PTU	.870	RM	.766
MULTI CLAIM	.975	RM	MBRO	PTU	.955	RM	MBRO	.954	RM	.920
CRP SING CL	.874	RM	RA	PTU	.873	RM	RA	.829	RM	.709
NRL SING CL	.885	RM	BBET	RA	.873	BBET	RM	.859	BBET	.770
NON-CRP SING CL	.910	RM	PTU	BBET	.898	RM	PTU	.885	RM	.776

a. General Results

In all cases examined, with the exception of losing ROs, the values of R-Squared range from about 0.85 to 0.95 for a six factor model. Since an R-Squared value of 1.0 means the regression model precisely explains the data set, the above results mean that the factors selected in the ONR evaluation capture the main considerations used by the reviewers to determine their OPE scores.

In all cases examined, the values of R-Squared for a three factor model are within 3% of the values of R-Squared for a six factor model, and usually within 1%. These three factor models consist of RM, RA or one of its surrogates (MBRO, BBET, which used to be included under RA), and except in the Physical Sciences RO case, PTU.

In all cases examined, the values of R-Squared for a two factor model are within 4% of the values of R-Squared for a three

factor model, and usually within 2%. These two factor models consist of RM, and either PTU, or RA or one of its surrogates. In all cases, the drop in the value of R-Squared in going from a two factor model to a one factor model ranges from 0.04 to about 0.2, usually averaging about 0.1. The one factor models consist of RM, with the exception of BBET for NRL.

The relatively small gradients in the magnitude of the value of R-Squared in going from a six factor model to a two factor model implies that the reviewers used two, and sometimes three, main factors in deciding the worth of a proposal. The choice of factors differed for claimants, technical areas, etc., but the number of key factors always remained small.

b. Key Specific Results

For the CRP, research considerations (RM, RA) predominate in determining OPE, while for the non-CRP, mission relevance considerations (PTU) play a secondary but non-negligible role relative to RM in determining OPE. This implies that, to some extent, the reviewers are applying weightings to different factors which go beyond the technical discipline under consideration and depend on the proposing organization

For NRL, BBET plays the primary role in determining OPE, and RM plays a secondary but non-negligible role in determining OPE

In the regressions of OPE against RO size, no correlations were observed. Thus, OPE score is independent of RO size.

In the regressions of OPE score against Phase of R&D, no correlations were observed (R-Squared approximately zero). The conclusion is that OPE score is independent of Phase of R&D.

2. PHASE OF R&D ANALYSIS RESULTS

The Phase of R&D factor reflects the reviewers' judgement as to where an RO lies along the 6.1 - 6.2 - 6.3 spectrum. A picture of how all ONR ROs, or subdivisions thereof, are distributed across this spectrum is valuable for understanding whether ONR claimants are following their charters relative to basic/ applied research, and for gaining general insight into the program. Forty nine separate cases were analyzed, and the results are presented as histograms (distributions by discrete bands) of ROs' first year dollars across the different phases of R&D.

The results for the first level ONR categorizations are summarized in Figures 2-A to G. These figures contain distributions (by discrete bands) of Research Options' first year dollars across the different phases of R&D for different parameter combinations. On all of these figures, the top band represents the first year dollar value of Research Options whose panel-averaged Phase of R&D scores placed them in the earliest stages of basic research. The next to the top band contains ROs judged to be in the intermediate stages of basic research. Within the band which bounds basic and applied research (labeled basic/appl), the specific programs above the midpoint of the band are counted as

basic research and those below are counted as applied research. As the bands proceed further downward, the research becomes more applied.

```
.......ALL ONR ANALYSIS-FIGURE 2-A

VERY BASIC..........:xxxxxxxxx
BASIC...............:xxxxxxxxxxxxxxxxxxxx
BASIC/APPL..........:xxxxxxxxxxx
APPLIED.............:xxxx
VERY APPL...........:x
....................0..................20
............................$M
```

For ALL ONR, the distribution is reflective of a mission-oriented basic research program, with the highest dollar amplitude in the middle of the basic research region, and a modest dollar amplitude at the upper and lower bounds of the basic research region. About 84% of the total RO funds are in basic research, and the remainder are in applied research. Since the ONR annual guidance to the claimants suggests a basic/ applied research split of about 80% basic and 20% applied, it can be inferred that the claimants are indeed following the guidance for the present case.

```
.....................CLAIMANT ANALYSIS-FIGURE 2-B

..............CRP.............................NRL

VERY BASIC...:xxxxxxxxxxx....................:
BASIC........:xxxxxxxxxxxxxxxxxxxx...........:xxxxxxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxx......................:xxxxxxxxxxxxxxxx
APPLIED......:x..............................:xxxxxxxxxxxxxx
VERY APPL....:...............................:xxx
.............0...................50..........0..................6


..............ARP..........................SMALL.CLAIMANTS

VERY.BASIC...:xxxxx.......................:xxxxxxxxx
BASIC........:xxxxxxxx....................:xxxxxxxxx
BASIC/APPL...:xxxxxxxxxxxxxx..............:xxxxxxxxxxxxxxxxxxxx
APPLIED......:xxxxxxxxxxxxxxxxxxxx........:xxxxxxxxxxxx
VERY APPL....:xxxxxxxxx...................:xxx
.............0...................4........0..................3
.......................$M...........................$M
```

The CRP's distribution is centered in the basic research region, while NRL's distribution is centered on the basic/ applied research boundary. Since NRL is a full spectrum R&D laboratory, the researchers would probably be intermixed with, or may also be working in, the higher category levels of development. The more

applied flavor of the proposed NRL research relative to that of the CRP may be a reflection of the closer ties of the NRL researchers to the ongoing NRL development work, and would also be reflective of more definable transition paths for the research.

Compared to the CRP and NRL, the ARP's (an applied research unit within ONR) distribution is distinctly different, peaking near the center of the applied research region. In particular, the CRP and ARP distributions appear to form a complementary set, overlapping at the basic/applied research boundary. This is a heartening result, for it reflects the separate but tandem missions established for these two organizations. It shows further that the ARP has been able to sustain the precarious position of remaining centered within the applied research region without drifting into exploratory development.

```
...................TIME TREND ANALYSIS-FIGURE 2-C

..............POM.87.........................POM.88

VERY.BASIC...:xxxxxxxxxx....................:xxxxx
BASIC........:xxxxxxxxxxxxxxxxxxxx..........:xxxxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxxx....................:xxxxxx
APPLIED......:xxxx..........................:
VERY.APPL....:..............................:x
.............0....................15........0..............22
......................$M...........................$M

..............POM.89.........................POM.90

VERY.BASIC...:xxxxxx........................:xxxxxxxxxxxxxxxxxx
BASIC........:xxxxxxxxxxxxxxxxxxxx..........:xxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxxxxxxxxxxx............:xxxxxxxxxxxxx
APPLIED......:xxxxxxxxxxx...................:xxxx
VERY.APPL....:..............................:xx
.............0..................13..........0..................13
......................$M..............................$M
```

When POM year is varied, there do not appear to be any time monotonic trends discernible

```
.................TECHNICAL.DISCIPLINE.ANALYSIS-FIGURE.2-D

..............PHYSICAL.SCIENCE...............ENVIRONMENTAL.SCIENCE

VERY.BASIC...:xxxxxxxxxxxxxxx...............:xxxxxxxxxxxxxx
BASIC........:xxxxxxxxxxxxxxx...............:xxxxxxx
BASIC/APPL...:xxxxxxxxxx....................:xxxxxxxxxxxxxxxxxx
APPLIED......:xxxx..........................:xxx
VERY.APPL....:xx............................:
.............0..................18...........0...................17
......................$M...............................$M
```

```
..............ENGINEERING.SCIENCE...........LIFE.SCIENCE

VERY.BASIC...:..............................:xx
BASIC........:xxxxxxxxxxxxxxxxxxx...........:xxxxxxxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxx.....................:x
APPLIED......:xxxxx.........................:xxx
VERY.APPL....:x.............................:
.............0..................17..........0..................18
......................$M..............................$M
```

The ONR Physical Science ROs are concentrated mainly in the basic research region, with a very modest amount tapering off into the applied research region. The Environmental Sciences ROs appear to have a deficiency in the center of the basic research region. One partial explanation results from the following observations over the past five POMs. The Ocean Sciences/Atmospheric Sciences components of Environmental Sciences tend to be fairly fundamental in nature, and many of them would fit in the top band. However, many Acoustics ROs have been quite sizable, and tend to be more in the direction of applied research. These would probably populate the band on the boundary of basic/applied research.

The ONR Engineering Sciences ROs have an absence of dollars in the most fundamental research band, which also correlates with observations over the past five POMs. The remainder of the Engineering Sciences distribution parallels that of the Physical Sciences ROs very closely. The Life Sciences RO distribution appears almost totally concentrated in the middle of the basic research region.

```
........................SIZE ANALYSIS-FIGURE 2-E

..............LARGE.ROs......................SMALL.ROs

VERY.BASIC...:xxxxxxxx......................:xxxxxxxxxxx
BASIC........:xxxxxxxxxxxxxxxxxxxx..........:xxxxxxxxxxxxx
BASIC/APPL...:xxxxxxx.......................:xxxxxxxxxxxxxxxxxx
APPLIED......:xx............................:xxxxxxxxxx
VERY.APPL....:..............................:xxx
.............0..................48..........0..................16
......................$M.............................$M
```

By arbitrary definition, large ROs have first year funding greater than $1 million, and small ROs have first year funding less than or equal to $1 million. While the distribution for small ROs is broader than the distribution of large ROs, there appears to be little difference in Phase of R&D, for the distribution means, between the large and small ROs for all ONR, for the CRP, and for the non-CRP.

```
.................SINGLE VS MULTI-CLAIMANT ANALYSIS-FIGURE 2-F

...............SINGLE.CLAIMANT...............MULTICLAIMANT

VERY.BASIC...:xxxxxxxxxx.....................:xxxxxxx
BASIC........:xxxxxxxxxxxxxxxxxxxx...........:xxxxxxxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxxxx....................:xxxxxxxxxxxxxx
APPLIED......:xxxxx..........................:xxx
VERY.APPL....:x..............................:
.............0..................44...........0..................15
......................$M...............................$M
```

The ONR single and multi-claimant distributions appear to have about the same means. The bands on both extremes of the single claimant distribution are either reduced or eliminated on the multi claimant distribution. Personal observations over the past five POMs lead to the conclusion that the addition of claimants to an RO proposal tends to have the effect of adding 'filters', with extremes being eliminated. Further, because of the diversities in Phase of R&D contributed by each of the claimants, and the requirement that each RO be given only one score for this factor, there tends to be an averaging by the reviewers, a diffusive process which has the effect of 'trimming the wings' of the factor distribution.

```
.....................WINNERS VS LOSERS ANALYSIS-FIGURE 2-G

...............WINNING.ROs...................LOSING.ROs

VERY.BASIC...:xxxxxxxxxx.....................:xxxxxxxxxxx
BASIC........:xxxxxxxxxxxxxxxxxxxx...........:xxxxxxxxxxxxxxxxxx
BASIC/APPL...:xxxxxxxxxxx....................:xxxxxxxxxxxxxx
APPLIED......:xxxx...........................:xxxxxx
VERY.APPL....:...............................:xx
.............0..................44...........0..................15
......................$M..............................$M
```

*Phase of R&D score appears to have no discernable impact on whether an RO will win or lose, for ONR as a whole, or for the CRP. Phase of R&D may have a slight influence on whether a non-CRP RO will win or lose, but this may be due to some other factor which is highly correlated with Phase of R&D.

3. Overall Program Evaluation Score Analysis

OPE is the factor which has the strongest influence on the final RO score. Study of the distribution of dollars among the OPE scoring bands for all ONR ROs, or subdivisions thereof, can identify strengths or weaknesses in various components of the program. Forty nine separate cases were analyzed, and the results are presented as histograms (distributions by discrete bands) of ROs' first year dollars across the different OPE scoring bands.

The results for first level ONR categorizations are summarized in Figures 3-A to G. These figures contain distributions (by discrete bands) of Research Options' first year dollars as a function of Overall Program Score for different parameter combinations. On all of these figures, the top band represents the first year dollar value of Research Options whose panel consensus Overall Program Evaluation Scores placed these ROs in the Fair-Average category. The next band to the top can be viewed as Average-Good; the next band below can be viewed as Good-Very Good; and the bottom band can be viewed as High or Outstanding.

.....<u>ALL ONR ANALYSIS</u>-FIGURE 3-A

```
FAIR/AVER.......:xx
AVER/GOOD.......:xxxxxxx
GOOD/VERYGOOD...:xxxxxxxxxxxxxxxxxxxx
HIGH............:xxxxx
................0..................82
........................$M
```

For all ONR proposed ROs, the bulk are in the Good - Very Good range, which corroborates personal observation over the past five POMs. The proposed ROs which come from the claimants for the overall competition typically have not been reviewed formally by expert external panels. It is conjectured that a rigorous pre-review by external expert panels convened by the claimants would filter out the Fair-rated and most of the Average-rated ROs.

<u>CLAIMANT ANALYSIS</u>-FIGURE 3-B

```
................CRP........................NRL

FAIR/AVER......:x..........................:x
AVER/GOOD......:xxxxx......................:xxxxxxxxx
GOOD/VERYGOOD..:xxxxxxxxxxxxxxxxxxx........:xxxxxxxxxxxxxxxxxx
HIGH...........:xxxxxx.....................:xx
...............0.................64........0..................11
.......................$M...........................$M


................ARP.........................SMALL.CLAIMANTS

FAIR/AVER......:xxxxx......................:xxxxxxxxxxxxxxxx
AVER/GOOD......:xxxxxxxxxxxxxxxx...........:xxxxxxxxxxxxxxxxxx
GOOD/VERYGOOD..:xxxxxxxxxxxxxxxxxxxx.......:xxxxxxxxxxxxxxxxxxx
HIGH...........:xxxxxxx....................:...................
...............0...................5.......0..................3
.......................$M...........................$M
```

The CRP distribution is very similar to that of the total ONR, with the exception that there are slightly less dollar fractions in the two lower score bands. The major differences between the CRP

and NRL distributions seem to be that the CRP has a higher dollar fraction in the Outstanding band and the NRL has a somewhat higher dollar fraction in the Average-Good band.

```
...................TIME TREND ANALYSIS-FIGURE 3-C

..................POM.87....................POM.88

FAIR/AVER........:xx........................:
AVER/GOOD........:xxxxx.....................:xxxxxxx
GOOD/VERYGOOD....:xxxxxxxxxxxxxxxxxxxx......:xxxxxxxxxxxxxxxxxx
HIGH.............:xxxxxxxxxx................:xx
.................0..................18......0..................25
..........................$M..........................$M

...................POM.89....................POM.90

FAIR/AVER.........:x........................:xxxx
AVER/GOOD.........:xxxxxxxxx................:xxxxx
GOOD/VERYGOOD.....:xxxxxxxxxxxxxxxxxxxx.....:xxxxxxxxxxxxxxxxxxx
HIGH..............:xxxxx....................:xxxx
..................0..................20.....0..................20
...........................$M.........................$M
```

*There do not seem to be any major observable trends with time, and the main common feature among the different POM year results is that the highest proportion of ROs are scored in the Good-Very Good band. Unfortunately, no method appears to have been discovered for eliminating proposals in the Fair-Aver band or improving the overall average quality of a POM year's proposals.

```
.....................TECHNICAL DISCIPLINE ANALYSIS-FIGURE 3-D

...................PHYSICAL.SCIENCE..........ENVIRONMENTAL.SCIENCE

FAIR/AVER.........:x........................:xxxx
AVER/GOOD.........:xxxx.....................:xxxxxxxxxxxxx
GOOD/VERYGOOD.....:xxxxxxxxxxxxxxxxxxxx.....:xxxxxxxxxxxxxxxxxxx
HIGH..............:xxxx.....................:xxxxx
..................0..................32.....0..................19
...........................$M.........................$M

...................ENGINEERING.SCIENCE.......LIFE.SCIENCE

FAIR/AVER.........:x........................:xxxx
AVER/GOOD.........:xxxxx....................:xxxxxxx
GOOD/VERYGOOD.....:xxxxxxxxxxxxxxxxxxxx.....:xxxxxxxxxxxxxxxxxx
HIGH..............:xx.......................:xxxxxxxxxxxx
..................0..................21.....0..................11
...........................$M.........................$M
```

ONR Physical Sciences and Life Sciences distributions are quite similar. Relative to these two distributions, the Environmental Sciences distribution has a greater dollar fraction in the Average-Good band (the other three bands having about the same dollar fraction) and the Life Sciences distribution has a greater dollar fraction in the Outstanding band.

The OPE scores presented here are actual non-normalized panel consensus scores. Each of the technical areas discussed here was nominally evaluated by one or more expert panels. Thus, differences in distributions and mean scores among panels could be due to differences in quality of the proposals, or could be due to differences in how reviewers interpret the definitions of the scoring bands. There has been a normalization done on panel scores for the past three POM years. In the normalization, it is assumed that half the difference between any two panels' mean scores is due to a quality difference in the proposals, and the other half of the difference is due to the relative severity of the panelists in assigning scores. It is the normalized scores which determine the final scores and prioritizations of the proposals. However, personal observations and informal 'shadow' reviews over the past five POMs confirm the findings of the distributions in this section. Most notably, the Life Science ROs tend to have a few more Outstanding contributors than those of the other disciplines, and the Environmental Science ROs tend to have more of a contribution of Average members.

```
........................SIZE.ANALYSIS-FIGURE.3-E

...................LARGE.ROs................SMALL.ROs

FAIR/AVER.........:x.........................:xxx......
AVER/GOOD.........:xxxx......................:xxxxxxxxxxxx
GOOD/VERYGOOD.....:xxxxxxxxxxxxxxxxxxxx.....:xxxxxxxxxxxxxxxxxxx
HIGH..............:xxxxxx...................:xxx
..................0........$M........58.....0.........$M.......24
```

*The large ROs seem to score slightly higher than the small ROs. However, this may be due to the arbitrary choice of a dividing line between large and small. In the regression section of this report, OPE was correlated with RO size, with no arbitrary dividing lines present, and OPE score was shown to be independent of RO size.

```
...............SINGLE VS MULTI-CLAIMANT ANALYSIS-FIGURE 3-F

...................SINGLE.CLAIMANT..........MULTICLAIMANT

FAIR/AVER.........:*.........................:***
AVER/GOOD.........:******....................:**********
GOOD/VERYGOOD.....:********************.....:******************
HIGH..............:****.....................:********
..................0........$M........67.....0.........$M.......16
```

The distributions of ONR single and multi claimancy are quite similar, and the means appear about the same. The CRP single and multi claimancy distributions are very similar. While the non-CRP multiclaimant ROs have a higher fraction of Outstanding/Very Good dollars, they also have a higher fraction of Average/Very Good dollars. There appears to be no major difference between the two distributions. The CRP single claimant distribution has a smaller dollar fraction in the lower bands, and a larger dollar fraction in the higher bands, than the non-CRP single claimant distribution. The same holds true for the CRP multiclaimant distribution relative to the non-CRP multiclaimant distribution. Since the CRP is essentially a partner to all multiclaimant ROs (with a few exceptions), if it had the same share of all multiclaimant ROs, the CRP and non-CRP multiclaimant distributions would be identical. The fact that the CRP distribution reflects higher scores than the non-CRP distribution means that the multiclaimant ROs with higher CRP contribution score higher than those with lower contribution.

```
..................WINNERS VS LOSERS ANALYSIS-FIGURE 3-G

...................WINNING.ROs...............LOSING.ROs

FAIR/AVER.........:.........................:xxxxxxxx
AVER/GOOD.........:xxx......................:xxxxxxxxxxxxxxxxxxx
GOOD/VERYGOOD....:xxxxxxxxxxxxxxxxxxxx....:xxxxxxxxxxxxxxxxx
HIGH..............:xxxxxx...................:
..................0..................67.....0..................18
...........................$M.........................$M
```

*The bulk of the winning ONR ROs are in the Good range or higher; the bulk of the losing ROs are below the Good range, and there is some overlap. It should be noted that the next to the bottom band contains ROs whose OPE scores range from 7.0 to 8.5. Personal observations over the past five POMs lead to the conclusion that there is a substantial difference between ROs at the upper end of this range and at the lower end. Most of the losing ROs in this range scored at the lower end. There is a small fraction of winners in the Average-Good band. These are un-normalized scores; some of the final scores were increased due to the normalization procedure. Also, in different POM years, the threshhold values for funding ROs differed.

Attachment 17 - TECHNICAL/PROGRAMMATIC ISSUES FOR PROGRAM REVIEW

A) TECHNICAL ISSUES

1. FOR EACH COMPONENT OF THE APPLIED RESEARCH PROGRAM, ADDRESS THE FOLLOWING:

a. WHAT ARE THE TECHNICAL OBJECTIVES?

b. WHAT ARE THE KEY TECHNICAL ROADBLOCKS TO BE OVERCOME

c. WHY WAS THE PARTICULAR TECHNICAL APPROACH CHOSEN?

d. WHAT IS THE FEASIBILITY OF THE TECHNICAL APPROACH FOR ACHIEVING THE TECHNICAL OBJECTIVES?

e. IDENTIFY THE PROGRESS AND ACCOMPLISHMENTS MADE TOWARD ACHIEVING THE OBJECTIVES.

f. IDENTIFY THE RISK IN ACHIEVING THE OBJECTIVES.

g. WHAT ARE THE PROJECTED CAPABILITIES THE COMPONENT WILL PROVIDE AND HOW WILL THEY CONTRIBUTE TO THE TOTAL PROGRAM; HOW DO THESE CAPABILITIES COMPARE WITH THE STATE-OF-THE-ART AND WITH POTENTIAL CAPABILITIES OF OTHER TECHNICAL APPROACHES?

h. WHAT MORE FUNDAMENTAL RESEARCH RESULTS ARE UTILIZED TO INSURE SUCCESS OF THE PROGRAM? IF NEEDED FUNDAMENTAL RESEARCH INFORMATION IS NOT AVAILABLE, WHAT FALLBACK POSITIONS EXIST?

2. IF THE PROGRAM OBJECTIVES ARE ACHIEVED, WHAT IS THE PROBABILITY THAT THE INDIVIDUAL COMPONENTS AND/OR THE TOTAL PROGRAM ARE TRANSITIONABLE. WHAT IS THE EVIDENCE TO SUPPORT YOUR RESPONSE.

3. WHAT IS THE LOGICAL STRUCTURE AND PROGRESSION OF THE TEST PROGRAM? WHAT VALIDATIONS WILL BE ACHIEVED FROM EACH STEP OF THE TEST PROGRAM, INCLUDING LAB TESTS AND FIELD TESTS?

4. WHAT IS THE TECHNICAL FOCUS OF THE TOTAL PROGRAM? HOW ARE DISCRETE COMPONENTS BEING INTEGRATED INTO A UNIFIED PROGRAM?

5. WHAT IS THE BALANCE BETWEEN RESOURCES AND TECHNICAL OBJECTIVES? IS THE TOTAL PROGRAM SUFFICIENTLY FOCUSED FOR THE RESOURCES, OR IS IT TOO DILUTED AMONG THE DIFFERENT COMPONENTS?

B) PROGRAMMATIC ISSUES

1. WHAT IS THE MANAGEMENT AND WORK BREAKDOWN STRUCTURE OF THE PROGRAM?

2. WHAT ARE THE MILESTONES TO ACHIEVE THE PROGRAM OBJECTIVES; WHAT WILL BE DEMONSTRATED, AND WHEN?

3. WHAT ARE THE CRITICAL PATHS, AND HOW COULD THEY IMPACT THE SCHEDULE?

4. FUNDING DISTRIBUTION BY TASK AND PERFORMER FOR EACH YEAR.

5. CHANGES IN SCOPE FROM ORIGINAL PLANS, AND RATIONALE SUPPORTING THESE CHANGES.

6. PROGRAM SHORTFALLS TO DATE, IMPACT ON OVERALL GOALS, AND PLANS FOR MITIGATION

7. PROGRAM COORDINATION WITH OTHER AGENCIES AND WITH INDUSTRY, BOTH DOMESTIC AND FOREIGN.

8. HOW WOULD THE PROGRAM BE AFFECTED IF THE MONEY WERE SPREAD OVER FOUR YEARS INSTEAD OF THREE YEARS; TWO YEARS INSTEAD OF THREE YEARS; HOW WOULD THIS AFFECT RISK?

EVALUATION CRITERIA FOR APPLIED RESEARCH PROGRAM REVIEW

I) TECHNICAL CRITERIA

PROVIDE COMMENTS ON THE TECHNICAL ISSUES IDENTIFIED ABOVE AND ANY OTHER TECHNICAL ISSUES WHICH YOU FEEL ARE RELEVANT TO THIS PROGRAM. ADDRESS STRENGTHS AND WEAKNESSES, AND INCLUDE RECOMMENDATIONS FOR IMPROVING THE PROGRAM.

II) PROGRAMMATIC CRITERIA

PROVIDE COMMENTS ON THE PROGRAMMATIC ISSUES IDENTIFIED ABOVE AND ANY OTHER PROGRAMMATIC ISSUES WHICH YOU FEEL ARE RELEVANT TO THIS PROGRAM. ADDRESS STRENGTHS AND WEAKNESSES, AND INCLUDE RECOMMENDATIONS FOR IMPROVING THE PROGRAM.

ALTERNATIVE APPLIED RESEARCH PROGRAM EVALUATION FORM

REVIEWER'S NAME____

1. IS THE INVESTMENT STRATEGY APPROPRIATE FOR AN APPLIED XXXXXXXXXX RESEARCH PROGRAM? WAS THE PRIORITIZATION AND ALLOCATION OF RESOURCES AMONG RESEARCH COMPONENTS SUPPORTED BY A LOGICAL RATIONALE? IS THERE AN APPROPRIATE BALANCE BETWEEN REQUIREMENTS-DRIVEN (TOP-DOWN) AND OPPORTUNITIES-DRIVEN (BOTTOM-UP) APPLIED RESEARCH IN THE PROGRAM? HOW CAN VERTICAL INTEGRATION WITHIN THE PROGRAM BE IMPROVED?

2. FOR EACH RESEARCH COMPONENT OF THE XXXXXXXXXXX RESEARCH PROGRAM, ADDRESS THE FOLLOWING:

2a. ARE THE TECHNICAL OBJECTIVES CLEAR AND RELATED TO THOSE OF THE TOTAL PROGRAM?

2b. ARE THE KEY TECHNICAL ROADBLOCKS TO BE OVERCOME IDENTIFIED?

2c. IS THE PARTICULAR TECHNICAL APPROACH CHOSEN APPROPRIATE?

2d. IS THE TECHNICAL APPROACH FOR ACHIEVING THE TECHNICAL OBJECTIVES FEASIBLE?

2e. ARE THE PROGRESS AND ACCOMPLISHMENTS MADE TOWARD ACHIEVING THE OBJECTIVES ACCEPTABLE?

2f. ARE THE RESEARCH TECHNICAL QUALITY AND PRODUCTIVITY SUFFICIENT?

2g. IS THE RISK APPROPRIATE IN ACHIEVING THE OBJECTIVES.

2h. ARE THE PROJECTED CAPABILITIES THE COMPONENT WILL PROVIDE AND CONTRIBUTE TO THE TOTAL PROGRAM ADEQUATE; HOW DO THESE CAPABILITIES COMPARE WITH THE STATE-OF-THE-ART AND WITH POTENTIAL CAPABILITIES OF OTHER TECHNICAL APPROACHES?

3. IF THE PROGRAM OBJECTIVES ARE ACHIEVED, WHAT IS THE PROBABILITY THAT THE INDIVIDUAL COMPONENTS AND/OR THE TOTAL PROGRAM ARE TRANSITIONABLE? WHAT IS THE EVIDENCE TO SUPPORT YOUR RESPONSE?

4. WHAT IS THE TECHNICAL FOCUS OF THE TOTAL PROGRAM? HOW ARE DISCRETE COMPONENTS BEING INTEGRATED INTO A UNIFIED PROGRAM?

5. WHAT IS THE BALANCE BETWEEN RESOURCES AND TECHNICAL OBJECTIVES? IS THE TOTAL PROGRAM SUFFICIENTLY FOCUSED FOR THE RESOURCES, OR IS IT TOO DILUTED AMONG THE DIFFERENT COMPONENTS? IS THERE AN APPROPRIATE BALANCE AMONG ANALYSIS, THEORY, COMPUTER MODELING, LAB TESTING, FIELD TESTING, AND HARDWARE DEVELOPMENT?

6. IS THE PROGRAM COORDINATION WITH OTHER FEDERAL AND STATE AGENCIES AND INDUSTRY (AND FOREIGN, IF APPLICABLE) ADEQUATE? IS THERE SUFFICIENT LEVERAGING OF THESE LARGER EXTERNAL PROGRAMS?

PROVIDE COMMENTS ON THE TECHNICAL ISSUES IDENTIFIED ABOVE AND ANY OTHER TECHNICAL ISSUES WHICH YOU FEEL ARE RELEVANT TO THIS PROGRAM. ADDRESS STRENGTHS AND WEAKNESSES, AND INCLUDE RECOMMENDATIONS FOR IMPROVING THE PROGRAM.

Attachment 18 - REVIEW PROTOCOL FOR SMALL SEED MONEY PROJECTS

Many organizations have special programs which consist of small, high risk, finite duration projects. These programs have a variety of names, such as seed money or independent research. They may have a variety of purposes, such as attracting high level staff, maintaining staff technical competency, maintaining awareness of the cutting edge external R&D community, and identifying future investment areas for the organization. Because of these projects' small size and high risk nature, high intensity assessments during their lifetimes may be counterproductive. The remainder of this section describes a protocol for evaluating these projects at the completion of their execution phase. The protocol combines the best of several different agencies' review practices of small projects, and recommends inclusion of some unique features.

For purposes of this discussion, it is assumed that the central evaluation mode is panel peer review. The underlying review philosophy is that it is neither cost-effective or necessary for each project to be presented in its entirety before the panel, as would be the case with larger sized projects. If the main purpose of the program is to help the organization position itself for the future in cutting edge science and technology, then the project presentations need contain only that threshold amount of information which will describe the investment strategy that leads to the stated organizational goal. However, since Lotka's Law states that only a small percentage of research projects will have substantial payoff, and assessment studies have shown that organizations need to have these few 'heavy-hitters' to maintain vigor and viability, a few expanded presentations of the best projects will be required to determine whether the organization has its share of high payoff potential research projects.

For most of the projects presented, two or three vugraphs of material would be sufficient. These viewgraphs should contain very short statements of the research objectives, the technical approach, the potential payoff to the organization (relevance to the organization's mission), results obtained, research products generated (paper and patent references, etc.), and coordination with other organizations (relation to complementary work in other organizations). Total presentation time for each of these projects should not exceed three or four minutes. The best of the projects would have presentation time expanded to about 15 minutes per project, would have more focus on results and transition possibilities, and would be subject to more detailed scrutiny by the review panel. Review forms presented in some of the previous attachments could be utilized for this review.

In order for this abbreviated presentation approach to be effective, the panel has to receive descriptive material about all the projects beforehand. These writeups would be about two to five pages in length, and would contain the supporting details of the items summarized on the vugraphs. Thus, the panel members would enter the review with some understanding about the technical details, and could focus on project linkages and investment strategy during

the review. The next attachment recommends other information which could help streamline the review further.

Consider the following example. Assume a lab has a $3M per year program consisting of 60 seed money projects, and assume one third of the program is reviewed each year. Assume these projects can be aggregated equally into four technical disciplines, such as materials, acoustics, mechanics, and remote sensing. The review would consist of the following. The seed money program manager would spend about 30-45 minutes overviewing the program. This would include the lab's mission, and how it relates to the corporate sponsor's mission. It would also include the seed money program's objectives, and how they relate to the lab's mission. It would describe selection and management criteria for the projects. Then, after the overview, an expert in each technical discipline would present the projects within that discipline. Four of the five projects within the discipline would require about 15 minutes total, and the fifth (best) project would require about 15 minutes by itself. Thus, each discipline would require about 30 minutes for presentation, and the total review, including overview, would be about three hours. By the end of the review, the panel would understand the program's objectives, the strategy for choosing the projects, the importance of the projects to science and the organization, how the projects would help position the organization for the future, and whether some high quality results were obtained.

To close the loop, the reviewers' comments would be sent anonymously to the program manager. The manager would be required to respond in writing to the comments, including descriptions of actions to be taken as a result of the critiques. The manager's comments would be circulated to the reviewers to ascertain their satisfaction, and a final statement of satisfaction or dissatisfaction would be sent by the reviewers to the assessment manager.

Attachment 19 - USE OF PUBLISHED PAPERS IN RESEARCH PROGRAM EVALUATION

The conduct of research project/ program peer reviews in many agencies appears designed more for the comfort of the participants rather than the efficient exchange of information. Especially in panel reviews, the presentation focus tends to be on intricate technical details rather than the investment strategy. The technical details address mainly the job right component of peer review, whereas the investment strategy has the focus of the right job component. Much of the detailed technical information could be supplied to the reviewers beforehand, and the valuable but usually quite limited presentation period could be devoted more to understanding the investment strategy rationale. However, the reviewers and presenters (and usually the audience) tend to be trained technically, are more comfortable in discussing technical details, and, because of their background expertise in the areas being reviewed, are usually willing to accept the right job aspects of the technical area as fundamentally important.

It is the author's firm contention that as much useful background information as possible should be supplied to the reviewers of a research program/ project before the actual review occurs. In addition to the narratives suggested previously, there is another source of valuable information that has been almost completely neglected during any of the many different agency project/ program reviews the author has attended. This information is the written peer reviews of the project's papers that were submitted, accepted, and/or published by refereed journals. The following discussion proposes that fuller use be made of these journal peer reviews in the research program peer review process.

A published paper is really not research, it is a documentation of research. However, while this observation mainly impacts the importance ascribed to bibliometric counts in assessing research productivity and quality, it says little about the intrinsic value of a published paper for use in research evaluation. Because of the effort generated by authors/ editors/ reviewers in the paper publication process, there is much information in the paper and the publication process that could be valuable in research program evaluation.

Under the present system of manuscript publishing, papers are submitted by a researcher(s) to a journal. The papers are then sent by the journal editor, or proxy, to one or more experts in the field for review (typically two or three experts). For a technical article, the author(s) tends to supply many details of the technical approach, as well as other useful information. During the manuscript review, typically the reviewers spend substantial time addressing the intricate details of the technical approach used in the research (as well as addressing other criteria). The paper may be accepted or rejected outright, or accepted pending approved revision. The reviewers' comments, and the submitter's rebuttal (if any) stay within the editor-submitter-reviewer group. Thus, if a researcher has one published paper during a year, and this is presented to a

panel of experts as part of a project/ program review, all the panel knows is that the paper passed the threshold requirements for a particular journal. The panel does not know how many journals rejected the article, what the comments of the rejecting peer reviewers were, what the rebuttal comments of the submitter were, or what the specific comments of the accepting journal peer reviewers were. This information would be very useful to have during a project/ program review, since it could reduce the need for the presentation of copious technical detail during the review, and allow more time for discussion of higher order issues such as investment strategy and relevance to organizational objectives.

Since the sponsoring agency pays for the research, it has every right to have full access to reviewers' comments on the products of the research. Otherwise, the agency is being excluded from external reviews of research which it has supported. The journal reviewers have typically expended much effort in the technical review process, and the valuable information contained in their comments is not being used for the fullest benefit to the rightful recipients of this information, the research sponsors.

For a paper which results from sponsored research, an agreement is required between the research sponsoring agencies/corporations and the research journals that the sponsor of the paper's research be identified when it is submitted for publication. Once the paper has been reviewed, a copy of the journal reviewers' comments would be sent to the sponsoring organization as well as to the article submitter. In return for the journal's efforts, the sponsoring organization would provide some financial compensation to the journal for the review and comments. Under this system, writers of low-to-average quality articles would be less motivated to submit randomly to different journals, since the peer reviews would be transmitted to their sponsoring organizations. This would have the positive effect of reducing the overwhelming volume of mediocre articles submitted to and published in the literature. Also, these journal reviews would be submitted to the sponsor's project evaluation panels as background material, and, as stated above, would reduce the need for detailed exposition of technical approach which presently consumes much of the presentation time of project reviews.

This approach would probably result in a positive Darwinian selection process. The good researchers who recognize that they are doing good research would be motivated to publish more, while the mediocre/average researchers who recognize that they are doing mid-level research would be motivated to publish less. The differences in numbers and quality of published papers between the good researchers and average researchers would be accentuated and would become more evident to the review panel, and the papers would then have more of an impact on the panel's evaluation of a project. The journals would be partially compensated for their efforts, and the journal reviewers could conceivably be partially compensated for their efforts. This could make journal reviewing a more attractive process to reviewers, and might improve some of the review quality issues described in the peer review Quality section of this document.

Attachment 20 - FUNDS ALLOCATIONS BASED ON REVIEWERS' SCORES

Background

One issue which has not been addressed so far is the relation of the results of a research evaluation or impact assessment to the impact on the unit being evaluated. In the specific case of a program assessment, there are multiple philosophies as to the required actions based on the outcome.

One school of thought assumes the program to exist because of strategic value to the organization. If the program fares poorly in an evaluation, the funding should not suffer because of the strategic value. In this case, program management could be changed, the program could be restructured and the portfolio modified, but the funding would be preserved.

Another view assumes that all programs have strategic value, but that the final impact of the research on the organization and on society is heavily dependent on the quality of the research. If a program receives a poor evaluation, it is either reduced or vertically cut (terminated) and the resources are shifted to programs which fared better in the evaluation.

The remainder of this section presents an analytic approach for shifting resources based on program evaluation scores. The approach relies heavily on program quality, but is sufficiently flexible to take into account the strategic value of the program to the organization. It is also sufficiently flexible to apply to the allocation of resource increases or decreases to programs based on their quality scores while recognizing their strategic value to the organization.

Introduction

In the early/mid 1980s, the author examined program evaluation data from a number of different organizations. In particular, the author focused on programs that were assessed through evaluation of their component projects. In many cases, as will be described further, there was a linear relationship between project quality and cumulative funding for the program.

A specific example will clarify the preceding statement. Assume a program consists of ten projects, each having a value of 100K. Assume that a review has been held, and the projects received the following quality scores: 10, 9.5, 9, 8.5, 8, 7.5, 7, 6.5, 6, 5.5. For conceptual purposes, order the projects by decreasing scores, and plot project score as a function of cumulative project funding. Thus, the coordinates of the first project are [10, 100K], the coordinates of the second project are [9.5, 200K], third project [9, 300K], and so on. The graph will have the following appearance as shown by the ones (1).

```
.........10..z...1
.........9...........z...1
.........8...................z...1
.........7...........................z...1
.........6...................................z...1...
QUALITY..5...........................................z
.Q($)....4..............................................
.........3............................................
.........2............................................
.........1............................................
.........0............................................
...........0..100.200.300.400.500.600.700.800.900.1000
......................CUMULATIVE.FUNDING.-.$K
```

Because of the discrete nature of the numbers, the graph does not contain the coordinate [10, 0K]. The author's observations of the data were that most programs contained this point, and therefore the model should contain this point. To convert the graph to a continuous function which contains the point [10, 0K], the graph is shifted and replotted as shown by the z.

When the project evaluation data is plotted as above, the following hypothetical interpretation can be made. If funds are removed from this program, the lower quality projects will be eliminated, and both the threshold quality of the lowest remaining project and the average program quality will be raised. Conversely, if funds are added to this program, lower quality projects will be added, and both the threshold quality of the lowest project and the average program quality will be lowered.

Assume there are two programs which have been evaluated, where one program (Ph) received a higher evaluation than the other program (Pl). In the above model, the lowest ranked projects in Ph will have higher quality than the lowest ranked projects in Pl. If the objective of the reallocation process is to raise the total quality of Ph and Pl combined, then funds must be shifted from Pl to Ph. This will result in the elimination of the lowest ranked projects in Pl and the addition of more conceptually lower ranked projects in Ph. However, the new projects added to Ph will be of conceptually higher quality than those removed from Pl. By the principle of marginal utility, the total combined quality of Ph and Pl will be maximized when the quality of the lowest ranked project in each program is the same.

This is the principle behind the reallocation algorithm to be developed. An example will be shown for the linear case. The figure below is shown for the more general linear case, where $P represents the total funding in the program.

```
.........10....z...1
.........9.............z...1
.........8.....................z...1
.........7............................z...1
.........6.................................z...1...
QUALITY..5...Qm...............................z
..Q($)...4...........................................
.........3...........................................
.........2...........................................
.........1...........................................
.........0...........................................
...............0..100.200.300.........................$P
........................CUMULATIVE.FUNDING.
```

For multiple programs which have been evaluated, the objective is to maximize the sum of the dollar-weighted quality of all the programs. This can be stated mathematically as:

```
........$P1'.............$P2'
MAX {INT....Q1($)d$ + INT....Q2($)d$ + .....}..................(1)
........0................0
```

where INT represents the integral and ranges from 0 to \$Pi', Qi is quality of program i as a function of funds \$, and \$Pi' is the new total funding for program i which will maximize the integral. Qm on the graph is the minimum value of Q, Qmi, for program i.

For the assumed linear relation between Q and \$, Q can be written as

```
Qi($) = 10 + 2*((Qiav-10)/($Pi))*$.............................(2)
```

where Qiav is the funds weighted average of quality for program i.

If equation 2 is substituted into equation 1, the maximization problem becomes

```
MAX {(10*$P1'+((Q1av-10)/$P1)*$P1'^2) +
.....(10*$P2'+((Q2av-10)/$P2)*$P2'^2) +
...................................}..........................(3)
```

subject to the constraint that

```
SUM {$P1' + $P2' + ...} = $TOT................................(4)
```

where \$TOT is the total investment in all the programs.

The following example was run using the nonlinear programming package bundled with Excel 4.0. Assume five programs have been evaluated with the following average program scores: 9, 8, 7, 6, 5. Assume each program had \$10M in funds. The optimization routine yielded the following results.

PROGRAM	Qiav	$Pi	$Pi'	Qm	Qm'	TOTQUAL	TOTQUAL'
Prog.1	9	10	21.9	8	5.62	90	171
Prog.2	8	10	10.9	6	5.62	80	86
Prog.3	7	10	7.3	4	5.62	70	57
Prog.4	6	10	5.5	2	5.62	60	43
Prog.5	5	10	4.4	0	5.62	50	34
						SUM=350	SUM=390

Thus, program 1 increased in funding from \$10M to \$21.9M as a result of the evaluation. Its minimal quality project had an initial value of 8 (Qm), and after the funds increase its minimal quality project had a value of 5.62 (Qm'), the same value as the minimal quality project of the other programs. This was predicted above because of the principle of marginal utility. The total funds weighted quality increased from 350 to 390. Obviously, this type of result could have been obtained manually if very few programs were evaluated. For tens, or hundreds, of programs a computerized method is essential for uniformity and consistency.

The method is not restricted to a linear relation between quality and funding. If it is desired to emphasize the strategic nature of the programs more, and reduce the impact of quality on the reallocation, then a nonlinear function can be selected in which quality is a weaker function of funding. Given the uncertainty in the accuracy and precision of reviewers' scores, this type of nonlinear relationship would soften the effects of any uncertainties on funding redistributions. If it is desired to strongly emphasize quality and approach the vertical cut limit, then a nonlinear function can be selected in which quality is a stronger function of funding. All that is required is to substitute the desired nonlinear function into equation 2, and proceed as above.

The following example incorporates some nonlinear functions. Assume the following relationship between Q and \$, which is a more general version of equation (2):

$$Qi(\$) = 10 - (a(i)^{\wedge}n)*\$ \qquad (5)$$

where a(i) is a coefficient to be determined by the boundary conditions. When Q = Qmi, \$ = \$Pi, and it can be shown that

$$a(i) = (10-Qmi)/((\$Pi)^{\wedge}n) \qquad (6)$$

Combining (5) and (6) yields:

$$Qi(\$) = 10 - ((n+1)*(10-Qiav)/(\$Pi^{\wedge}n))*(\$^{\wedge}n) \qquad (7)$$

For n = 1, (7) reduces to (2).

The maximization problem can now be written:

$$\text{MAX } \{(10*\$P1'+((Q1av-10)/(\$P1^{\wedge}n))*(\$P1'^{\wedge}(n+1)) + \ldots(10*\$P2'+((Q2av-10)/(\$P2^{\wedge}n))*(\$P2'^{\wedge}(n+1)) + \ldots\ldots) \qquad (8)$$

subject to the constraint that

SUM {\$P1' + \$P2' + ...} = \$TOT .... (9)

For n = 1, (8) reduces to (3).

Now assume five programs have been evaluated with the following average program scores: 9, 8.5, 8, 7.5, 7. Assume each program had \$10M in funds. The optimization routine yielded the following results for n = .5, 1, 2.

n=.5

PROGRAM	Qiav	\$Pi	\$Pi'	Qm	Qm'	TOTQUAL	TOTQUAL'
Prog.1	9	10	25.4	8.5	7.61	90	214
Prog.2	8.5	10	11.3	7.8	7.61	85	95
Prog.3	8	10	6.4	7	7.61	80	53
Prog.4	7.5	10	4.1	6.3	7.61	75	34
Prog.5	7	10	2.8	5.5	7.61	70	24
						SUM=400	SUM=420

n=1

PROGRAM	Qiav	\$Pi	\$Pi'	Qm	Qm'	TOTQUAL	TOTQUAL'
Prog.1	9	10	17.2	8	6.55	90	143
Prog.2	8.5	10	11.5	7	6.55	85	95
Prog.3	8	10	8.6	6	6.55	80	71
Prog.4	7.5	10	6.9	5	6.55	75	57
Prog.5	7	10	5.7	4	6.55	70	48
						SUM=400	SUM=414

n=2

PROGRAM	Qiav	\$Pi	\$Pi'	Qm	Qm'	TOTQUAL	TOTQUAL'
Prog.1	9	10	13.4	7	4.62	90	110
Prog.2	8.5	10	10.9	5.5	4.62	85	90
Prog.3	8	10	9.5	4	4.62	80	78
Prog.4	7.5	10	8.5	2.5	4.62	75	70
Prog.5	7	10	7.7	1	4.62	70	63
						SUM=400	SUM=410

Thus, for the square root relationship (n=.5) between quality and project funds, substantial funds are shifted to the highest scoring project because the high quality drops off very slowly with increasing addition of funds. This relationship is more appropriate for a quality program emphasis. Conversely, for the square relationship (n=2), relatively few funds are shifted because of the assumed rapid dropoff of quality with increased funds. This relationship is more appropriate for a strategic program emphasis.

The method is also applicable to the cases where funds are added to or subtracted from an organization's research budget. The constraint on total funds is changed (equation 4), and the optimization proceeds as before.

Attachment 21 - POTENTIAL USE OF ENTROPY IN RESEARCH EVALUATION

In the assessment of research or research impact,. many types of distribution patterns occur. There are funds allocations across technical disciplines, funds allocations across performers, funds allocations across levels of development and the other cross-cuts mentioned in Attachment 2 on investment strategy, papers produced in different disciplines, papers co-authored in different disciplines, papers published in different types of journals, citations by papers in different disciplines, citations by people from different types of institutions and different countries, patents produced in different technologies, patents cited by papers and patents in different disciplines, etc. While these distributions are sometimes listed or catalogued during an assessment, they are rarely, if ever, subjected to a pattern analysis. Such an analysis would offer a much richer insight to research impacts or management processes than are offered by the standard examination of magnitudes alone. The use of entropy to characterize these distribution patterns offers a potentially substantial improvement in output interpretation of an assessment.

In statistical mechanics, the entropy is related to the number of micro-states (or states of the system at the atomic level) per macro-state (state of the system at the classical thermodynamic level). The statistical interpretation of the second law is that entropy tends toward the most probable state. The system proceeds from a state of order to disorder.

The information theory use of entropy is related to the statistical mechanics definition. If a system consists of N total units, and these units are distributed among m different states with a distribution function n(i), then the entropy s of the system may be written as:

```
...................i=m
............s.=.-SUM..p(i)*ln((p(i))                          (1).
...................i=1
```

where SUM represents the summation over all states i, and p(i) is the ratio of n(i) to N.

Thus, for any distribution n(i), equation (1) allows the entropy to be computed. The entropy can be interpreted as a measure of the order, or breadth, of the distribution, and its change can be tracked with time. It can serve as a single figure of merit for analyzing the distribution diversity of any quantity.

Examples of application of the entropy concept to two of the distribution patterns mentioned above follow.

Citations by Papers in Different Journals

One of the measures of research program impact is the number of citations of papers produced by the program. The initial part of this Handbook provides references of some citation studies under the bibliometrics category of the quantitative methods section. While the number of citing papers is very important, information about the citing papers can be extremely valuable. What is the distribution of

citing papers among different technical disciplines; among different journals; among different institutions; among different countries? How can the impact of the program papers on the citing papers be quantified relative to the above and other characteristics of the citing papers? The following application of the entropy concept provides a starting point for the quantification, but it will be shown that additional measures are necessary for further insight into the impact.

Assume that a paper has received 1000 citations by journal papers. Assume also that the citing papers can be categorized by journal quality (level 1, level 2, level 3), where each journal quality category is denoted by i. Then the entropy of the distribution is the same as that given above:

```
.....................i=3
............s.=.-SUM...p(i)*ln((p(i))/kappa
.....................i=1
```

where p(1) is the fraction of citing papers in journal of level 1 quality, p(2) is the fraction in level 2, p(3) is the fraction in level 3, and kappa is a constant which will produce an entropy s upper limit of unity.

The following table illustrates how the entropy function varies with different numbers of citing papers in the different journal types.

LEVEL.1	998	990	900	800	700	600	500	400	333
LEVEL.2	1	5	50	100	150	200	250	300	333
LEVEL.3	1	5	50	100	150	200	250	300	333
ENTROPY	01	06	36	58	75	87	95	99	1.0

As all citing papers are concentrated into one journal type, the entropy measure goes to zero, and as the citing papers are divided equally among journal types, the measure goes to one. However, the table illustrates the limitations of using the entropy measure alone. If the paper had received 2000 citations distributed among the journal types in the same ratio, the entropy measure would have been the same. Clearly the total impact would not be reflected in the entropy measure as used here. This effect could be overcome by using the analogy with entropy in classical thermodynamic systems. The entropy measure above could be defined as an entropy per unit, and then multiplied by the total number of units in the system to get total entropy. However, the measure would now be substantially greater than unity in the full disorder limit, could be subject to more misinterpretation, and the measure would lose its utility.

To measure impact of the original paper on the citing papers, other measures will be employed in addition to the entropy function. These other measures are the moments Mj of the citing paper distribution function n(i). The jth moment Mj of the distribution function n(i) is defined as:

$$M_j = \sum_{i=1}^{m} (i^j) * n(i)$$

where $n(i)$ is the number of citing papers in journal type i.

To show why using the moments of the distribution function is useful, and to aid in the interpretation of what follows, an analogue of the citing process to a nuclear interaction process is provided. For example, if a high energy proton interacts with a natural uranium target, neutrons will be released from the uranium by spallation, evaporation, and fast fission [Kostoff, 1979]. These released neutrons will have a wide range of velocities, which can be characterized by a velocity distribution function. The released neutrons can also interact with other targets and have additional neutron multiplication effects, depending on the energy of the incoming neutron and the composition of the target. With the use of kinetic theory (collisionless for large mean free path neutrons), moments of the released neutron velocity distribution function can be used to obtain macro-state information about the released neutron stream.

The citing process has some analogues to the neutron production process described above. The original published paper is analogous to the high energy proton. The technical community that reads the published paper is analogous to the natural uranium target. The citing papers produced by the technical community are analogous to the neutrons produced. The quality of the journals in which the citing papers are published is analogous to the velocities of the different neutrons.

The zeroth moment of the citing paper distribution function is:

$$M0 = \sum_{i=1}^{m} n(i)$$

In analogy to kinetic theory, where the zeroth moment of the particle velocity distribution is the mass density, the zeroth moment of the citing paper distribution shown above is the number of citing papers, or the citing paper mass.

The first moment of the distribution function is:

$$M1 = \sum_{i=1}^{m} i * n(i)$$

In analogy to kinetic theory, where the first moment of the particle velocity distribution is the momentum (mass*velocity) of the particle stream, the first moment of the citing paper distribution is the citing paper impact.

The second moment of the distribution function is:

```
........i=m
M2.=.SUM..(i^2)*n(i)
........i=1
```

In analogy to kinetic theory, where the second moment of the particle velocity distribution is the energy (mass*velocity^2) of the particle stream, the second moment of the citing paper distribution is the citing paper energy.

The third moment of the distribution function is:

```
........i=m
M3.=.SUM..(i^3)*n(i)
........i=1
```

In analogy to kinetic theory, where the third moment of the particle velocity distribution is the flux of particle energy (mass*velocity^3), the third moment of the citing paper distribution is the citing paper energy flux.

Thus, sole use of the zeroth moment of the citing paper journal type distribution provides a very gross measure of the impact (the number of citing papers) but offers little information about the quality of the impact. In this particular example, information about the types of user audience is at least as important as numbers of users. Is the author of the original paper reaching the intended audience? Use of the entropy of the citing paper journal type distribution shows the diversity of the user audience.

Use of the first moment allows the importance assigned to the different journal types to be factored in the analysis. To compute the first moment, journal type i has to be assigned a numerical value which reflects its importance. In analogy to kinetic theory, this numerical value is the effective "velocity" of journal type i. With use of this effective velocity, computation of the first moment yields the momentum, or total citing paper impact. In analogy to kinetic theory, the ratio of the first moment to the zeroth moment is the citing paper "average velocity", or average impact/citing paper.

Use of the second moment accentuates the difference in importance of the various journals. For distributions which have similar values of total impact, use of the "energy" will identify which of those distributions rely on "velocity" more than "mass" for their impact. For distributions which have similar values of total impact and energy, and where more differentiation is required, third or higher moments can be employed. The following example illustrates this point. In this example, two citing paper journal distributions, A and B, were compared for a domain of six journals of different quality. The distributions were selected such that the entropy and zeroth, first, and second moments were equal. The computational results follow.

```
.{...1.....2.....3.....4.....5.....6...}--NUMBER.OF.JOURNAL
..n(3)..n(4)..n(5)..n(6)..n(7)..n(8)..s.....M0....M1.....M2......M3
A.200...100...200...100...300...100...95..1000..5500..33100..212500
B..92...269...218...112....86...223...95..1000..5500..33100..214815.
```

The first row represents the six journals. The first six columns of the second row represent the citing paper distribution function for the six journals. The number in parentheses is the value of quality (effective velocity) assigned to each of the six journals. Thus, the entry in the first column of the second row, n(3), is interpreted as the number of citing papers in journal 1, where journal 1 has a quality value of 3. Continuing on the second row, s is the entropy of the citing paper journal distribution, M0 is the zeroth moment of this distribution, M1 is the first moment, M2 is the second moment, and M3 is the third moment. Rows three and four are the values of these columns for cases A and B.

All of the figures of merit are the same for the two cases except the third moment M3. While two cases with so many equal figures of merit would be an extremely rare occurrence, the example does show the discriminatory capability of the moment approach. In this case, use of even higher moments would provide more separation between the numerical results, and allow more insight for the interpretation of the results.

To track the figures of merit through time, and extract useful information, analogies can be made with aerodynamics trajectory analysis. An aerodynamic vehicle's state can be tracked through space and time to generate its trajectory (position in space and time). The first time derivative of its trajectory is its velocity, the second derivative is the acceleration, and the third derivative is the agility (ability to move inertial forces rapidly). Thus, the entropy and the moments in the above example could be plotted as a function of time, and their derivatives obtained. Valuable information could be obtained from the derivatives to see how the impact of an organization's output is changing over time, and how rapidly shifts are occurring, especially in response to new management initiatives.

Funds Allocations Across Disciplines or Levels of Development

Quantitative measures of the degree of vertical or lateral integration in an organization or in a group of programs would be useful to management for tracking purposes. It would also be useful for organizational assessments in being able to display the status of vertical or lateral integration. While quantitative measures are incomplete by themselves, and for the lateral or vertical integration measure here do not address the strength of the linkages among the different related disciplines or levels of development, they do provide a starting point for identifying potential problem areas.

Vertical or lateral integration within an organization makes it easier for multiple level of development or discipline funds to be managed jointly and at lower levels in the organization. The degree of multiple level of development or discipline funds management by an organizational unit is one component of vertical or lateral integration.

The quantitative measure proposed here for ascertaining the funds mixing component of vertical or lateral integration is the degree to which different categories of funds are managed jointly and at the lower levels in the organization. From this perspective, one

aspect of vertical or lateral integration can be viewed as a process by which management of different level of development or discipline funds by the same unit diffuses into the lower levels of the organization.

The measure could take different mathematical forms. Some desirable limiting conditions include: 1) for a given amount of funds managed by the unit of interest (say, a Technical Manager), the measure should go to zero as all funds are lumped into one level of development or discipline; 2) the measure should go to one as the funds are equally divided among the levels of development or disciplines; 3) the measure should range between zero and one and be smooth in this region.

Many mathematical measures could be defined which have these desirable properties. Since the problem is in essence a funds mixing problem, and since there is a precedent for using entropy as a measure in physical or chemical mixing problems, the entropy definition above will be used as the metric for assessing the vertical or lateral integration funds mixing component.

The following example is for vertical integration, but with some modifications could apply equally well to lateral integration. Assume there are three levels of funds to be integrated: basic research, applied research, and development. Assume further that the unit of analysis is all programs under each Technical Manager in the organization. Then, for each Technical Manager, the entropy metric for his programs is given by the information theory expression for entropy:

$$s = -\sum_{i=1}^{i=3} p(i)*\ln((p(i))/\mathrm{kappa}$$

where p(1) is the fraction of the Technical Manager's funds in basic research, p(2) is the fraction in applied research, p(3) is the fraction in development, and kappa is a constant which will produce an entropy s upper limit of unity.

The following table illustrates how the entropy function varies with different amounts of funds in the different levels of development in the Technical Manager's program. Each column represents different distributions of a $1000 total program.

BAS.RES	999.999	999	990	900	800	700	600	500	400	333
APP.RES	.0005	5	5	50	100	150	200	250	300	333
DEVELOP	.0005	5	5	50	100	150	200	250	300	333
ENTROPY	0	.01	.06	.36	.58	.75	.87	.95	.99	1.0

As all funds are concentrated into one level of development, the measure goes to zero, and as the funds are divided equally among levels, the measure goes to one.

The first part of the following discussion applies to implementing the measure for tracking total organization performance, and the second part applies to implementing the measure for tracking individual program performance. The measure would be implemented in

the following manner for the total organization. The organization's management at all levels would examine all programs and decide how the funds integration should be structured. This is the key step in the process, and requires that the different modes by which vertical integration will be effected be defined and planned for implementation. There may be technical areas or Technical Managers where the vertical integration would be effected through close coordination and cooperation rather than funds mixing. For example, generic research areas with multiple higher level of development applications would be one candidate.

Once the degree of desired funds mixing has been determined within the context of the overall vertical integration structure, the measure chosen would be computed for each program and Technical Manager. The measure would be computed for the existing degree of funds mixing and for the desired degree of funds mixing (the funds mixing target). Aggregates of the measure for each Technical Manager, Division, Office, etc., and for the total organization would be computed and tracked. The actual measure levels would be tracked against the measure targets, and progress in achieving the targets monitored.

Because entropy does not define a pattern uniquely, supplemental measures would be of benefit. One such approach would be to track actual funds deviation from a desired funds mixing target. The starting point of this approach is to define the different level of development funds targets for each Technical Manager. Then, the square of the difference between the actual funds each Technical Manager has in each level of development at a point in time and the target funds for each level of development for the Manager would be computed and tracked. As time proceeds, this 'residual' should decrease. Aggregates of this 'residual' over Division, Office, total organization would be computed and tracked as proposed above for the entropy measure. This measure could be normalized in the form of a coefficient for easier interpretation, or could remain in the form of funds.

The entropy measure would also be useful for tracking programs over time as they pass through different levels of development. Well run programs would have hills and valleys in the entropy-time plot, with smooth temporal entropy gradients. A typical program would have low entropy when it is entirely in the basic research phase. Its entropy would rise to near unity as the program transitions from basic to applied research, and both types of funds are used to finance the program. The entropy would decrease again as the basic research funds are phased out and the applied research funds become dominant. The entropy would increase as applied research proceeds and development funds are phased in. These cycles would be repeated as the development process proceeds. In the tracking of the temporal entropy plot, if the entropy remains low during different development phases, this means that abrupt transitions to different phases are occurring. This condition is less desirable than the gradual transitions depicted above, and is readily observable from the entropy trajectory. Again, measures supplemental to entropy could be employed in the tracking process to enhance the interpretation of the

output. A quantitative tracking approach as described becomes especially useful when management must track tens or hundreds of programs.

In summary, the distribution patterns which occur in research assessments contain much useful information. Present techniques extract relatively little of this information in practice. Use of concepts from thermodynamics and other fields such as entropy, momentum, and energy can improve the information extraction process, and aid in the interpretation of the results through physical analogies.

VIII. ANALYSIS OF RIA LITERATURE

This section includes contributions from DR. RONALD N. KOSTOFF, OFFICE OF NAVAL RESEARCH; MR. HENRY J. EBERHART, NAVAL AIR WARFARE CENTER CHINA LAKE; MR. DARREL R. TOOTHMAN, DSTI, INC.; DR. ROBERT PELLENBARG, NAVAL RESEARCH LABORATORY.

INTRODUCTION

This section shows how Database Tomography can be used to derive technical intelligence from the published literature. Database Tomography is a patented system for analyzing large amounts of textual computerized material. It includes algorithms for extracting multi-word phrase frequencies and performing phrase proximity analyses. Phrase frequency analysis provides the pervasive themes of a database, and the phrase proximity analysis provides the relationships among the pervasive themes, and between the pervasive themes and sub-themes.

One potential application of Database Tomography is to obtain the thrusts and interrelationships of a technical field from papers published in the literature within that field. This section provides applications of Database Tomography to analyses of both the non-technical field of Research Impact Assessment (RIA) and the technical field of Chemistry.

A database of relevant RIA articles was analyzed to produce characteristics and key features of the RIA field. The recent prolific RIA authors, the journals prolific in RIA papers, the prolific institutions in RIA, the prolific keywords specified by the authors, and the authors whose works are cited most prolifically as well as the particular papers/ journals/ institutions cited most prolifically, are identified. The pervasive themes of RIA are identified through multi-word phrase analyses of the database. A phrase proximity analysis of the database shows the relationships among the pervasive themes, and the relationships between the pervasive themes and subthemes.

A similar process was applied to Chemistry, with the exception that the database was limited to one year's issues of the Journal of the American Chemical Society. Wherever possible, the RIA and Chemistry results were compared. Finally, the conceptual use of Database Tomography to help identify promising research directions was discussed.

BACKGROUND

Science and technology are assuming an increasingly important role in the conduct and structure of domestic and foreign business and government. In the highly competitive civilian and military worlds, there has been a concommittent increase in the need for scientific and technical intelligence to insure that one's perceived adversaries do not gain an overwhelming advantage in the use of science and technology. While there is no substitute for direct human intelligence gathering, there have become available many

techniques which can support and complement direct human intelligence gathering. In particular, techniques which identify, select, gather, cull, and interpret large amounts of technological information semi-autonomously can expand greatly the capabilities of human beings for performing technical intelligence.

This section shows how Database Tomography [Kostoff,1993f, 1994h, 1995e] can be used to derive technical intelligence from the published literature. As stated previously, Database Tomography is a patented system for analyzing large amounts of textual computerized material. It includes algorithms for extracting multi-word phrase frequency analysis and performing phrase proximity analyses. The phrase frequency analysis provides the pervasive themes of a database, and the phrase proximity analysis provides the relationships among the pervasive themes, and beteen the pervasive themes and sub-themes.

One potential application of Database Tomography is to obtain the thrusts and interrelationships of a technical field from papers published in the literature within that field. This section originated with a benchmark application of Database Tomography to analysis of the field of Research Impact Assessment (RIA).

To execute the study reported in this paper, a database of relevant RIA articles is generated using a unique search approach (See Section IX-A), and the database is analyzed to produce characteristics and key features of the RIA field. The recent prolific RIA authors, the journals prolific in RIA papers, the prolific institutions in RIA, the prolific keywords specified by the authors, and the authors whose works are cited most prolifically as well as the particular papers cited most prolifically, are identified. In addition, the most highly cited years, journals, and countries are also shown. The pervasive themes of RIA are identified through multi-word phrase analyses of the database. A phrase proximity analysis of the database shows the relationships among the pervasive themes, and the relationships between the pervasive themes and subthemes.

Based on the positive benchmark results for RIA, the application of Database Tomography to a technical field, Chemistry, was then performed, and the results from the two studies are compared where practical. To execute the Chemistry study, a database of all papers published in the 1994 edition of a leading Chemistry journal, the Journal of the American Chemical Society (JACS), as abstracted in the Science Citation Index (SCI) is generated, and the database is analyzed to produce characteristics and key features of the Chemistry field as reflected in JACS. The recent prolific JACS authors, the prolific institutions in JACS, the prolific keywords specified by the authors, and the authors whose works are cited most prolifically as well as the particular papers cited most prolifically, are identified. In addition, the most highly cited years, journals, and countries are also shown. The pervasive themes of JACS are identified through multi-word phrase analyses of the database. A phrase proximity analysis of the database shows the relationships among the pervasive themes, and the relationships between the pervasive themes and subthemes.

In the Appendices to this section, selected results from other Database Tomography studies are shown to display further capabilities of this system. One form of taxonomy from a Near-Earth Space study is shown; another type of taxonomy from a Former Soviet Union applied research study is presented; and a method to help identify promising research directions from computerized analysis of the published literature is discussed.

What is the importance of applying Database Tomography to a non-physical science field such as RIA, or a physical science field such as Chemistry? Database Tomography provides a map of the field of interest and, analogous to ordinary roadmaps, serves as a structured guide to reach a specific destination efficiently. Suppose one wants to understand the limitations of the major RIA techniques, and perhaps identify promising avenues for improving these techniques. One could start with hit-or-miss literature searches or randomized personal contacts, or one could start with Database Tomography.

Database Tomography would identify the main intellectual thrust areas in RIA or Chemistry, and the relationships among those thrust areas. As part of the analysis output, the main RIA or Chemistry techniques conceptualized and employed would be identified. The major journals associated with each thrust area and technique would be identified, the major authors for each technique and thrust area would be identified, and the major institutions and countries associated with each technique and thrust area would be identified. The ancillary techniques and the science and technology areas which could support and improve a technique or thrust area would be identified, and conversely techniques or thrust areas which could be impacted by a given technique would be identified.

The map, then, provides a comprehensive overview of the full picture, and allows specific starting points to be chosen rationally for more detailed investigations into a topic of interest. It does not obviate the need for detailed investigation of the literature or interactions with the main performers of a given topical area in order to make a substantial contribution to the understanding or the advancement of this topical area, but allows these detailed efforts to be executed more efficiently.

DATABASE GENERATION

The key step in the RIA literature analysis is the generation of the database. For the present study, the database consists of selected journal abstracts (including authors, titles, journals, author addresses, author keywords, abstract narratives, and references cited for each paper) obtained by searching the Science Citation Index (SCI) and the Social Sciences Citation Index (SSCI). The SCI accesses about 3000 journals (mainly in the physical sciences) and the SSCI accesses about half that amount (mainly in the social sciences). In the SCI and SSCI, the title, keyword, and abstract fields were searched using keywords relevant to RIA. The resultant abstracts were culled to those relevant to RIA.

The search was performed with the recently developed technique of Simulated Nucleation (See Section IX-A; also Kostoff, 1997f),

which includes two powerful Database Tomography tools: multi-word phrase frequency analysis and phrase proximity analysis. An initial database of titles, keywords, and abstracts was created from a core of papers known to be highly relevant to RIA. A phrase frequency analysis was performed on this textual database. The high frequency single, double, and triple word phrases obviously relevant to RIA were then used as search terms in the SCI and SSCI databases. The process was repeated on the new database of titles, keywords, and abstracts which was found. A few more iterations were performed until convergence was obtained. Before the final iteration, a phrase proximity analysis was performed on the database in addition to the phrase frequency analysis. This additional analysis provided relevant phrases closely related to the main themes which may not have had high frequency occurrence. The value of this search approach is that the search terms are obtained from the authors in the SCI and SSCI databases, not by guessing on the part of the searcher. The resulting final database may be the most complete RIA journal database in existence. The titles of the papers in the final RIA database are listed at the end of this Handbook.

As stated in the background section, the JACS database consisted of SCI abstractions of all the papers contained in the 1994 issues of JACS.

PROLIFIC AUTHORS

In both RIA and JACS, the author field was separated from the database, and a frequency count of author appearances was made. The most prolific authors follow, in order of decreasing publications. Two caveats are in order here.

For RIA, the journals searched were limited to those in the SCI and SSCI. Relevant articles in other journals were not included. Books or major reports were not included. The keywords used were a finite set of the author's discretion, and undoubtedly overlooked some relevant articles in RIA. The time frame of the articles included in the present analysis was 1991-early 1995. Thus, there may be excellent researchers writing in the field of RIA who were omitted from the following list due to the finite selection process, and the author's apologies are extended to anyone who falls into this category. In particular, those authors whose work has been referenced in the main body of this Handbook, and who do not appear on the following list, should be considered as an ex officio part of the list.

For the Chemistry component of the study, only JACS was used. The time frame of the study is 1994. Relevant Chemistry articles in other journals were not included. Books or major reports were not included. Thus, there are undoubtedly excellent researchers writing in the field of Chemistry who were omitted from the following list due to the finite selection process, and the authors' apologies are extended to anyone who falls into this category.

There were approximately 2300 RIA papers retrieved and approximately 2150 JACS papers. There were approximately 2975 RIA authors, and approximately 6535 JACS authors, which average to 1.3

authors per RIA paper, and 3 authors per JACS paper. The ratio of JACS authors per paper does not differ appreciably from the 3.37 authors per paper obtained in a recent study of the near-earth space literature. It appears that the RIA papers tend to be individual efforts, while the JACS (and space) papers tend to be team efforts. The JACS (and space) studies could involve multiple disciplines and potentially large experiments (certainly true for the space studies), which would account for the difference in authors per paper.

87.3% of the RIA authors produced one paper and 7.3% produced two papers, while 84.3% of the JACS authors produced one paper and 10.7% produced two papers. Thus, in both cases, about 5% of the authors produced three or more papers, although in each case the mode author produced one paper. However, as Table 1 shows, a few authors in each field produced an order of magnitude more papers than the average or mode author. While the RIA numbers are spread over four years, the JACS numbers are for a single year, and the top JACS numbers are quite impressive.

TABLE 1 MOST PROLIFIC AUTHORS - RIA

GARFIELD-E 91; SCHUBERT-A 18; VANRAAN-AFJ 17; GLANZEL-W 14; BRAUN-T 13; GRILICHES-Z 11; MCCAIN-KW 10; LEYDESDORFF-L 10; NARIN-F 9; KOSTOFF-RN 9; COURTIAL-JP 9; BONITZ-M 9; VINKLER-P 8; NEDERHOF-AJ 8; MOED-HF 8; EGGHE-L 8; ROUSSEAU-R 7; WELLJAMSDOROF-A 6; TIJSSEN-RJW 6; TERRADA-ML 6; PINERO-JML 6; PETERS-HPF 6; PERITZ-BC 6; PAO-ML 6; MENDEZ-A 6; MACZELKA-H 6; LANCASTER-FW 6;

TABLE 1A MOST PROLIFIC AUTHORS - JACS

SCHLEYER-PV 13, RHEINGOLD-AL 13, BOGER-DL 13, TROST-BM 10, PAQUETTE-LA 10, WHITESIDES-GM 9, SPIRO-TG 9, REBEK-J 9, MOROKUMA-K 8, LIPPARD-SJ 8, HROVAT-DA 8, HAW-JF 8, DIXON-DA 8, BUCHWALD-SL 8, BORDEN-WT 8, ADAM-W 8, KITAGAWA-T 7, HOUK-KN 7, GELLMAN-SH 7, BRAUMAN-JI 7, WILLNER-I 6, SQUIRES-RR 6, SCHREIBER-SL 6, ROBB-MA 6, OLIVUCCI-M 6, NICOLAOU-KC 6, INGOLD-KU 6, ECHEGOYEN-L 6, CLARDY-J 6, BORDWELL-FG 6, BERNARDI-F 6, BERGMAN-RG 6, ARDUENGO-AJ 6,

CODE: THE NUMBER FOLLOWING EACH AUTHOR'S NAME REPRESENTS THE NUMBER OF PAPERS AUTHORED OR CO-AUTHORED IN THE LITERATURE DATABASE.

PROLIFIC JOURNALS

A similar process was used to develop a frequency count of journal appearances for RIA. Similar limitations to those mentioned above apply to the journals, and similar apologies are extended to journals not listed. The most prolific journals follow in order of decreasing frequency. While many disciplines are represented in the RIA table, there seems to be large representation from the Medical/ Psychological Sciences field and the Information/ Library Sciences field. There are 645 separate journals listed for RIA. While the

average number of papers per journal is 3.57, the most prolific journals contain one to two orders of magnitude more RIA papers.

TABLE 2 MOST PROLIFIC JOURNALS - RIA

SCIENTOMETRICS 336; CURRENT CONTENTS/LIFE SCIENCES 139; CURRENT CONTENTS 86; CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES 68; CURRENT CONTENTS/CLINICAL MEDICINE 68; CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES 44; CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES 41; SCIENCE 40; NATURE 34; JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 33; BRITISH MEDICAL JOURNAL 31; JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 26; BEHAVIORAL AND BRAIN SCIENCES 25; SCIENTIST 20; SCIENCES 20; CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL 20; INFORMATION PROCESSING & MANAGEMENT 19; BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION 17; JOURNAL OF INFORMATION SCIENCE 16; AMERICAN PSYCHOLOGIST 16; LIBRARY & INFORMATION SCIENCE RESEARCH 15; HIGHER EDUCATION 15;

CODE: THE NUMBER FOLLOWING EACH JOURNAL REPRESENTS THE NUMBER OF PAPERS IN THE LITERATURE DATABASE PUBLISHED IN THE JOURNAL

PROLIFIC INSTITUTIONS

A similar process was used to develop a frequency count of institutional address appearances, and similar apologies are extended to institutions not listed. The most prolific institutions follow in order of decreasing frequency. It should be noted, especially with regard to the universities, that many different organizational components may be included under the single organizational heading. Lack of space precluded printing out the components under the organizational heading.

For RIA, 1125 institutions are represented (average 2 papers per institution, and 2.64 authors per institution), and for JACS, 750 institutions are represented (average 2.9 papers per institution, and 8.7 authors per institution). The most prolific RIA institutions are almost two orders of magnitude above the average in papers generated, while the most prolific JACS institutions are an order of magnitude above the average. These differences reflect the more concentrated nature of JACS papers in teams and institutions relative to those of RIA papers. Interestingly, even though the RIA and JACS subject matter are very different, a number of institutions rank as the most prolific in both fields (HARVARD UNIV, UNIV OF ILLINOIS, YALE UNIV, UNIV OF PENN, UNIV OF MINNESOTA, UNIV OF TEXAS, UNIV OF WISCONSIN).

TABLE 3 MOST PROLIFIC INSTITUTIONS - RIA

INST SCI INFORMAT 109; HARVARD UNIV 61; UNIV OF ILLINOIS 39; HUNGARIAN ACAD SCI 35; LEIDEN UNIV 32; INDIANA UNIV 32; UNIV OF MICHIGAN 31; YALE UNIV 25; UNIV OF PENN 23; UNIV OF N CAROLINA 22; UNIV OF MINNESOTA 21; UNIV OF TEXAS 21; UNIV OF LONDON 20; JOHNS HOPKINS UNIV 20; UNIV OF WISCONSIN 19; PENN STATE UNIV 19;

CSIC 19; UNIV OF SUSSEX 18; OHIO STATE UNIV 17; CORNELL UNIV 17; UNIV OF PITTSBURGH 16; UNIV OF CAMBRIDGE 16; STANFORD UNIV 16; UNIV OF MARYLAND 15; UNIV OF CALIF SAN FRANCISCO 15; UNIV OF CALIF DAVIS 14; DREXEL UNIV 14; UNIV OF IOWA 13; UNIV OF SO CALIF 13; UNIV OF INSTELLING ANTWERP 13; UNIV OF CALIF BERKELEY 12; UNIV OF CALIF LOS ANGELES 12;

TABLE 3A MOST PROLIFIC INSTITUTIONS - JACS

MIT 67; UNIV-ILLINOIS 56; UNIV-TEXAS 51; UNIV-CALIF-BERKELEY 51; SCRIPPS-CLIN-&-RES-INST 49; STANFORD-UNIV 47; CALTECH 46; HARVARD-UNIV 43; NORTHWESTERN-UNIV 39; UNIV-WISCONSIN 38; DUPONT-CO-INC 37; UNIV-MINNESOTA 35; EMORY-UNIV 35; UNIV-TORONTO 32; UNIV-PENN 32; PURDUE-UNIV 31; CORNELL-UNIV 30; YALE-UNIV 30; PRINCETON-UNIV 29; TEXAS-A&M-UNIV 29; COLUMBIA-UNIV 27; OHIO-STATE-UNIV 27; MICHIGAN-STATE-UNIV 27; UNIV-GEORGIA 25; INDIANA-UNIV 24; UNIV-PITTSBURGH 23; HEBREW-UNIV-JERUSALEM 23; UNIV-CALIF-SAN-DIEGO 22; UNIV-TOKYO 22; UNIV-WASHINGTON 22; UNIV-ROCHESTER 22; UNIV-DELAWARE 21; TOKYO-INST-TECHNOL 21; PENN-STATE-UNIV 20; UNIV-N-CAROLINA 20; OSAKA-UNIV 19; KYOTO-UNIV 19; CNRS 18; RUTGERS-STATE-UNIV 18; IOWA-STATE-UNIV-SCI-&-TECHNOL 17; UNIV-MICHIGAN 17; UNIV-CALIF-IRVINE 17; UNIV-VIRGINIA 17; UNIV-CALIF-SANTA-BARBARA 16; UNIV-ERLANGEN-NURNBERG 16; NAGOYA-UNIV 16; UNIV-CALIF-DAVIS 16; UNIV-CALIF-LOS-ANGELES 16; UNIV-FLORIDA 15; UNIV-ALBERTA 15; UNIV-BRITISH-COLUMBIA 15; NATL-RES-COUNCIL-CANADA 15;

CODE: THE NUMBER FOLLOWING EACH INSTITUTION REPRESENTS THE NUMBER OF TIMES A NAME OF A REPRESENTATIVE FROM THAT INSTITUTION APPEARS AS AN AUTHOR OR CO-AUTHOR IN THE LITERATURE DATABASE

PROLIFIC COUNTRIES

A similar process was used to develop a frequency count of institutional address appearances, and similar apologies are extended to institutions not listed. The most prolific countries follow in order of decreasing frequency.

For RIA, 56 countries are represented, and for JACS, 44 countries are represented. The United States is about an order of magnitude more prolific than its nearest competitor, and is as prolific as its major competitors combined. In the four studies performed so far using the present approach (RIA, Chemistry [JACS], Near-Earth Space, Hypersonic-Supersonic Flow), this dominant relationship between the United States and its nearest competitors is observed. Generically, the western democracies tend to be the most prolific. In addition, Japan is in the first JACS tier and second RIA tier; Hungary is high in RIA; and India and Russia are both well into the second RIA and JACS tiers.

TABLE 4 MOST PROLIFIC COUNTRIES - RIA

USA,1595;	UK,279;	CANADA,138;	NETHERLANDS,80;	GERMANY,79;
FRANCE,71;	AUSTRALIA,69;	SPAIN,58;	HUNGARY,46;	BELGIUM,45;
INDIA,32;	ISRAEL,30;	RUSSIA,29;	NORWAY,25;	JAPAN,23;
ITALY,22;	SWEDEN,21;	DENMARK,16;	SOUTH-AFRICA,16;	MEXICO,15;

TABLE 4A MOST PROLIFIC COUNTRIES - JACS

USA 2040; JAPAN 276; CANADA 168; GERMANY 148; FRANCE 116; UK 109; ITALY 97; SPAIN 58; SWITZERLAND 53; ISRAEL 48; NETHERLANDS 43; SWEDEN 40; AUSTRALIA 35; BELGIUM 18; DENMARK 18; SOUTH-KOREA 18; INDIA 12; RUSSIA 12; TAIWAN 8;

CODE: THE NUMBER FOLLOWING EACH COUNTRY REPRESENTS THE NUMBER OF TIMES A NAME OF A REPRESENTATIVE FROM THAT COUNTRY APPEARS AS AN AUTHOR OR CO-AUTHOR IN THE LITERATURE DATABASE

PROLIFIC CITATIONS

The citations in all 2300 RIA papers were aggregated into a file of over 37000 entries, and the citations in all 2154 JACS papers were aggregated into a file of over 85000 entries. The authors most frequently cited, the specific papers most frequently cited, the journals most frequently cited, and the years most frequently cited were identified. The highly cited authors, papers, journals, and years are presented in order of decreasing frequency.

While the numbers of RIA and JACS papers are about the same, there are more than twice as many citations per paper on average in JACS relative to RIA. However, many of the RIA articles were editorials or editorial-like, and did not contain references, and therefore no conclusions should be drawn about differences in numbers of citations per journal research article based on these data.

For RIA, there are 30400 papers and 18140 authors cited (average of 1.68 papers per author), and for JACS, there are 64800 papers and 32450 authors cited (average of 2 papers per author). Therefore, those RIA authors that do cite draw from a modestly wider group of authors than the JACS authors that cite. For RIA, 72% of authors cited are cited once and 14.5% are cited twice, while for JACS 60% of authors cited are cited once and 16.7% are cited twice. For RIA, 89.7% of the papers that are cited are cited once and 6.5% are cited twice, while for JACS, 83% of the papers that are cited are cited once and 11% are cited twice. Thus, the authors cited distribution seems to follow the more classic inverse hyperbolic Lotka's Law at low citations, while the paper cited distribution follows a somewhat sharper trajectory closer to a cubed law.

For RIA, a number of the most highly cited authors are also the most prolific (Garfield, Narin, Braun, Schubert). These particular authors are recognized leaders in the RIA field, and their work also focuses on the quantitative aspects of RIA. Because of the time lag between papers and citations, differences should be expected between the most prolific authors and the most cited authors. Authors who are new to the field and are prolific may have relatively few

citations. Also, some established authors who are highly cited may require substantial time to produce seminal papers.

For JACS, some of the most highly cited authors are also the most prolific (Boger, Trost). However, some of the prolific authors could have been highly cited in other journals, which would not have been reflected in this single journal study. Also, some of the highly cited authors could have been prolific in other journals.

For RIA, the first tier of highly cited papers represents many of the seminal quantitative approaches (Garfield, Schubert, Small, Lotka), while the second tier reflects the more qualitative approaches (Kuhn, Price, Cole). This should not be surprising, since with the advent of fast high-storage computers and massive databases, technology enables the shifting of focus to more quantitative data-intensive studies.

For the JACS database, the most highly cited papers reflect the evolution of metal-complex chemistry, with a continuing focus on transition metals (d-shell especially) reactions. There is a clear, continued emphasis on the synthesis (i.e. first reported formation) of a great variety of such complexes. Also reported are new and novel applications of instrumental techniques to characterize the new complexes, especially those involving organic moieties as ligands, especially application of such techniques as nuclear magnetic resources (NMR), X-ray diffraction, and mass spectrometry to determine the structure of new transition metal complexes. The body of literature analyzed (1994 JACS) clearly shows an increasing utilization of computer-based techniques as ab initio molecular orbital calculations, and molecular orbital calculations, and molecular mechanistic approaches to elucidate structure, and provide guidance in understanding mechanism of formation and catalytic pathways mediated by an increasing body of complexes.

For RIA, the most highly cited journals are congruent with the most prolific journals. The top five cited journals (Scientometrics, JASIS, Science, Nature, JAMA) are within the top seven prolific journals (if Current Contents is treated as a single journal). One would expect more congruence between the highly cited and highly prolific journals (and most highly cited and prolific institutions, if the data were available) than between the highly cited and prolific authors. The time lags between publication and citation are not insignificant relative to the span of an author's productive career, whereas the time lags for journals (and institutions) are relatively smaller compared to the period over which a journal (or institution) has established a reputation for publishing quality in given fields.

The JACS authors cited 6725 different journals and other sources, with an average of over 12.6 citations per journal. However, the most highly cited journal by far is JACS, receiving 25% of total citations, or three orders of magnitude higher citations than average. Its citations equal those of the next seven most cited journals combined.

TABLE 5 MOST CITED AUTHORS - RIA

GARFIELD-E 870; NARIN-F 181; PRICE-DD 159; BRAUN-T 142;
SMALL-H 141; SCHUBERT-A 139; MORAVCSIK-MJ 105; EGGHE-L 90;
MERTON-RK 90; MOED-HF 82; MCCAIN-KW 78; COLE-S 77;
LEYDESDORFF-L 77; ZUCKERMAN-H 77; BROOKES-BC 72; CALLON-M 71;
GRILICHES-Z 70; ARUNACHALAM-S 69; COLE-JR 66; NEDERHOF-AJ 65;
SMALL-HG 65; MARTIN-BR 64; LINDSEY-D 61; KOSTOFF-RN 60;
CRANE-D 58; CRONIN-B 57; ALLISON-PD 56; FRAME-JD 54;
CHUBIN-DE 53; MACROBERTS-MH 53; LINE-MB 52; PAO-ML 52;
CICCHETTI-DV 51; IRVINE-J 51; VINKLER-P 51; KUHN-TS 50;
VANRAAN-AFJ 50; LONG-JS 49; CARPENTER-MP 48; ABT-HA 47;
PERITZ-BC 46; PRICE-DJD 46; VLACHY-J 46; HARGENS-LL 45;
HAMILTON-DP 44; NALIMOV-VV 43; WHITE-HD 43; COURTIAL-JP 42;
LOTKA-AJ 40;

TABLE 5A MOST CITED AUTHORS - JACS

BOGER-DL 307; FRISCH-MJ 225; TROST-BM 175; DEWAR-MJS 171;
COREY-EJ 154; COLLMAN-JP 127; EVANS-DA 120; HEHRE-WJ 119;
BORDWELL-FG 116; WIBERG-KB 116; OLAH-GA 114; JORGENSEN-WL 108;
COTTON-FA 106; POPLE-JA 102; NICOLAOU-KC 99; ADAM-W 95;
LIAS-SG 87; LEHN-JM 86; MOSS-RA 86; BAX-A 82; PAQUETTE-LA 82;
MARCUS-RA 73; EVANS-WJ 71; HOFFMANN-R 71; ALLINGER-NL 64;
CURRAN-DP 64; BROWN-HC 63; DUNNING-TH 62; BECKWITH-ALJ 60;
CRABTREE-RH 60; SHELDRICK-GM 60; BROOKHART-M 59; TURRO-NJ 59;
DENMARK-SE 58; GOULD-IR 58; REED-AE 58; STILL-WC 58;
BERNARDI-F 56; CRAM-DJ 56; NEGISHI-E 56; NEWCOMB-M 56;
PAULING-L 56; BALDWIN-JE 55; KUBAS-GJ 55; HOUK-KN 54;
YAMAMOTO-Y 54; BARTON-DHR 53; JENCKS-WP 53; BECKE-AD 52;
DOYLE-MP 52; GROVES-JT 52; ARDUENGO-AJ 51;

CODE: THE NUMBER FOLLOWING EACH AUTHOR'S NAME REPRESENTS THE NUMBER OF TIMES THIS PERSON WAS FIRST AUTHOR OF A REFERENCE CITED IN THE LITERATURE DATABASE

TABLE 6 MOST CITED PAPERS - RIA

GARFIELD-E-1979-CITATION-INDEXING 55
SCHUBERT-A-1989-SCIENTOMETRICS-V16-P3 40
GARFIELD-E-1972-SCIENCE-V178-P471 40
SMALL-H-1973-J-AM-SOC-INFORM-SCI-V24-P265 35
LOTKA-AJ-1926-J-WASHINGTON-ACADEMY-V16-P317 35
KUHN-TS-1970-STRUCTURE-SCI-REVOLU 33
PRICE-DD-1963-LITTLE-SCI-BIG-SCI 32
COLE-JR-1973-SOCIAL-STRATIFICATIO 29
NARIN-F-1976-EVALUATIVE-BIBLIOMET 27
SMITH-LC-1981-LIBR-TRENDS-V30-P83 25
CRANE-D-1972-INVISIBLE-COLLEGES 24
PETERS-DP-1982-BEHAVIORAL-BRAIN-SCI-V5-P187 22
MERTON-RK-1973-SOCIOLOGY-SCI 22
MARTIN-BR-1983-RES-POLICY-V12-P61 22
SMALL-HG-1974-SCI-STUD-V4-P17 21
HAMILTON-DP-1990-SCIENCE-V250-P1331 20

MORAVCSIK-MJ-1975-SOC-STUD-SCI-V5-P86 19
KING-J-1987-J-INFORM-SCI-V13-P261 19
HOWARD-GS-1987-AM-PSYCHOL-V42-P975 19

TABLE 6A MOST CITED PAPERS - JACS

FRISCH-MJ-1992-GAUSSIAN-92,90
HEHRE-WJ-1986-AB-INITIO-MOL-ORBITA,65
DEWAR-MJS-1985-J-AM-CHEM-SOC-V107-P3902,50
FRISCH-MJ-1990-GAUSSIAN-90,39
HARIHARAN-PC-1973-THEOR-CHIM-ACTA-V28-P213,39
LIAS-SG-1988-J-PHYS-CHEM-REF-D-S1-V17,38
MOLLER-C-1934-PHYS-REV-V46-P618,38
STILL-WC-1978-J-ORG-CHEM-V43-P2923,28
HEHRE-WJ-1972-J-CHEM-PHYS-V56-P2257,24
LEHN-JM-1988-ANGEW-CHEM-INT-EDIT-V27-P89,24
MCMILLEN-DF-1982-ANNU-REV-PHYS-CHEM-V33-P493,23
REED-AE-1988-CHEM-REV-V88-P899,23
BECKE-AD-1988-PHYS-REV-A-V38-P3098,22
WEINER-SJ-1984-J-AM-CHEM-SOC-V106-P765,21
BONDI-A-1964-J-PHYS-CHEM-US-V68-P441,20
MOHAMADI-F-1990-J-COMPUT-CHEM-V11-P440,20
VOSKO-SH-1980-CAN-J-PHYS-V58-P1200,20
FRISCH-MJ-1992-GAUSSIAN-92-REVISION,19
JORGENSEN-WL-1983-J-CHEM-PHYS-V79-P926,19
POPLE-JA-1976-INT-J-QUANTUM-CHEM-S-V10-P1,19
WUTHRICH-K-1986-NMR-PROTEINS-NUCLEIC,19
HAY-PJ-1985-J-CHEM-PHYS-V82-P299,18
MARCUS-RA-1985-BIOCHIM-BIOPHYS-ACTA-V811-P265,18
PARR-RG-1989-DENSITY-FUNCTIONAL-T,18

TABLE 7 MOST CITED JOURNALS - RIA

SCIENTOMETRICS,1343; J-AM-SOC-INFORM-SCI,679; SCIENCE,646;
NATURE,388; JAMA-J-AM-MED-ASSOC,387; AM-PSYCHOL,346;
SOC-STUD-SCI,324; J-DOC,276; NEW-ENGL-J-MED,268;
RES-POLICY,251; CURR-CONTENTS,245; AM-SOCIOL-REV,222;
J-INFORM-SCI,183; COLL-RES-LIBR,141; LANCET,138;
AM-ECON-REV,123; ANN-INTERN-MED,115; ESSAYS-INFORMATION-S,114;
BRIT-MED-J,113; J-PERS-SOC-PSYCHOL,113; J-APPL-PSYCHOL,109;
INFORM-PROCESS-MANAG,98; PSYCHOL-BULL,98;

TABLE 7A MOST CITED JOURNALS - JACS

J-AM-CHEM-SOC 17883; J-ORG-CHEM 3257 ;J-CHEM-PHYS 2916;
TETRAHEDRON-LETT 2593;J-PHYS-CHEM-US 2496 ;INORG-CHEM 2204
BIOCHEMISTRY-US 1799 ;ANGEW-CHEM-INT-EDIT 1795 ;
J-CHEM-SOC-CHEM-COMM 1568 ; ORGANOMETALLICS 1312 ; SCIENCE
1226 ; CHEM-PHYS-LETT 1051 ; CHEM-REV 1039 ; TETRAHEDRON
997 ; ACCOUNTS-CHEM-RES 985 ; P-NATL-ACAD-SCI-USA 858 ;
J-BIOL-CHEM 813 ; NATURE 800 ; J-ORGANOMET-CHEM 721 ; UNPUB
681 ; J-CHEM-SOC 612 ; J-MOL-BIOL 525; CAN-J-CHEM 507; CHEM-BER

472 ; J-MAGN-RESON 470; J-COMPUT-CHEM 418; BIOCHIM-BIOPHYS-ACTA 379; ACTA-CRYSTALLOGR-B 361 ; B-CHEM-SOC-JPN 359;HELV-CHIM-ACTA 346 ; PURE-APPL-CHEM 342; CHEM-LETT 334; SYNTHESIS-STUTTGART 328 ; CHEM-PHYS 283 ; MACROMOLECULES 278 ; J-ANTIBIOT 277 ; ANGEW-CHEM 255 ; J-MED-CHEM 250 ; BIOPOLYMERS 242 ; LANGMUIR 239 ; MOL-PHYS 233 ; PHYS-REV-B 232 ; ANAL-CHEM 225 ; INT-J-MASS-SPECTROM 222 ; NUCLEIC-ACIDS-RES 222 ; J-CHEM-SOC-DALTON 215 ; J-CHEM-SOC-DA 209 ; BIOCHEM-BIOPH-RES-CO 204; THEOR-CHIM-ACTA 202;

TABLE 8 MOST CITED YEARS - RIA

1990,3092;	1989,2826;	1991,2726;	1988,2580;	1987,2177;
1992,2094;	1986,1942;	1985,1773;	1984,1436;	1983,1288;
1982,1217;	1993,1122;	1981,1092;	1979,1023;	1980,981;

TABLE 8A MOST CITED YEARS - JACS

1992 8297; 1993 7764; 1991 7470; 1990 6265; 1989 5282 ; 1988 4742 ; 1987 4072 ; 1986 3499 ; 1985 3299 ; 1984 2757 ; 1983 2445 ; 1982 2372 ; 1980 1991 ; 1981 1874 ; 0 1711 ; 1994 1669 ; 1978 1625 ; 1979 1537 ; 1977 1380 ; 1976 1343 ;

CODE: THE NUMBER FOLLOWING EACH PAPER REPRESENTS THE NUMBER OF TIMES THE PAPER WAS CITED IN THE LITERATURE DATABASE

PROLIFIC KEYWORDS

A similar process was used to obtain prolific keyword appearances. The paucity of RIA keywords is due to the fact that relatively few authors submitted keywords to the database. There are approximately an order of magnitude more keywords from JACS.

For RIA, the keywords, when viewed as an integral whole, describe the following RIA scenario: Use of Peer Review and quantitative Performance Indicators such as Citation Analysis and Bibliometrics for the purpose of Quality Assurance of University Publications from Medical and Educational Research.

For JACS, the keywords, when viewed as an integrated whole, describe the following scenario of chemistry as reflected in JACS: a continued focus on the synthesis of transition and heavy-metal complexes, and the elucidation of formation pathways (mechanisms) and structure of the various complexes. There is a continued emphasis on possible catalytic activity (especially redox reactions) associated with the complexes, and an increasing examination of the biological aspects at transition metal complex chemistry. Indeed, some cited work clearly examines the interactions of such bio-molecules as proteins and metals, both as metals catalyzing protein formation and/or controlling protein conformations. Also, the cited papers deal at length with instrumental techniques associated with metal-complex structure elucidation. As only one metal-complex structure out of many possible may prove to be active, structure elnsidation is clearly of interest within the research community.

TABLE 9 MOST PROLIFIC KEYWORDS - RIA

PEER REVIEW 19; RESEARCH 13; CITATION 7; CITATION ANALYSIS 7; CITATIONS 6; PUBLICATION 4; PERFORMANCE INDICATORS 4; BIBLIOMETRICS 4; UNIVERSITIES 3; QUALITY ASSURANCE 3; PUBLISHING 3; PUBLICATIONS 3; PREVENTION 3; PERFORMANCE 3; MEDICAL RESEARCH 3; ITALY 3; EDUCATIONAL RESEARCH 3; EDUCATION 3; DECISION SUPPORT SYSTEMS 3;

TABLE 9A MOST PROLIFIC KEYWORDS - JACS

COMPLEXES 220; CHEMISTRY 146; DERIVATIVES 120; SPECTROSCOPY 110; MECHANISM 108; MOLECULES 80; CRYSTAL-STRUCTURE 77; BINDING 68; ABINITIO 64; REACTIVITY 63; SPECTRA 61; PROTEINS 59; COMPLEX 56; LIGANDS 56; GAS-PHASE 54; ACID 53; 1 51; ENERGIES 47; WATER 46; MODEL 43; ORGANIC-SYNTHESIS 42; RESOLUTION 40; SYSTEMS 40; NMR 40; BOND 38; STRUCTURE 37; NUCLEAR-MAGNETIC-RESONANCE 37; RECOGNITION 37; CLEAVAGE 37; OXIDATION 37; MOLECULAR-STRUCTURE 36; PROTEIN 35; IONS 35; ALCOHOLS 35; GENERATION 35; DESIGN 35; DYNAMICS 33; CARBON 32; KETONES 32; DNA 31; RESONANCE 31; KINETICS 31; ESTERS 30; ACTIVATION 30; ELECTRON-TRANSFER 30; ELECTRONIC-STRUCTURE 30; AQUEOUS-SOLUTION 30; NUCLEAR MAGNETIC-RESONANCE 29; STEREOCHEMISTRY 29; REDUCTION 29; STATE 28; EXCHANGE 28; ANALOGS 27; CRYSTAL 27; HYDROGEN 27; PHOTOCHEMISTRY 26; LIGAND 26; REACTIONS 26; COORDINATION 25; DEPENDENCE 25;

CODE: THE NUMBER AFTER EACH KEYWORD REPRESENTS THE NUMBER OF TIMES THE KEYWORD APPEARED IN THE PAPERS OF THE LITERATURE DATABASE

PERVASIVE THEMES

To obtain pervasive themes, single, double, and triple word phrases from the text of the database were identified, and the high frequency high technical content phrases were identified as the pervasive themes. In this particular exercise, the databases for RIA and JACS were each split into two parts (titles and abstracts), and the analysis was done on each part. The titles of the papers were put into a separate database, and the multiword frequency analysis was performed. The abstracts of the papers constituted a separate database as well.

Following are the raw data outputs from these two sub-databases for both RIA and JACS. The number preceding the phrase is the frequency of appearance of the phrase in the database. Those phrases in RIA which are relatively specific are underlined, and will be used for future literature searches as keywords. The major themes include quantitative RIA approaches such as BIBLIOMETRICS/ SCIENTOMETRICS/ CITATIONS, qualitative approaches such as PEER REVIEW, and more generic terms such as (RESEARCH or SCIENCE) PRODUCTIVITY/ OUTPUT/ PERFORMANCE/ BENEFIT/ IMPACT.

The major Chemistry themes as reflected in JACS include study of Reactions (RATE CONSTANTS, TRANSITION STATE, ELECTRON TRANSFER, DIELS-ALDER) and Complexes (SPACE GROUP, TRANSITION-METAL, MOLECULAR-

HYDROGEN, CRYSTAL STRUCTURE) using both experimental approaches (X-RAY DIFFRACTION, NMR SPECTROSCOPY, MASS SPECTROMETRY) and computational approaches (COMPUTATIONAL QUANTUM CHEMISTRY, AB INITIO MOLECULAR ORBITAL METHODS, MOLECULAR MECHANICS CALCULATIONS).

TABLE 10 TITLE DOUBLE WORD FREQUENCIES - RIA

315 CITATION-CLASSIC COMMENTARY 116 CITATION- CLASSIC 115 CLASSIC COMMENTARY 43 CITATION ANALYSIS 35 PERFORMANCE INDICATORS 24 RESEARCH PRODUCTIVITY 22 EVALUATION RESEARCH 20 BIBLIOMETRIC ANALYSIS 16 RESEARCH PERFORMANCE 14 SCIENTIFIC PRODUCTIVITY 13 PEER-REVIEW PROCESS 13 SCIENTIFIC LITERATURE 12 LITTLE SCIENTOMETRICS 11 BIBLIOMETRIC STUDY 11 SCIENTIFIC PRODUCTION 10 CITATION IMPACT 10 PUBLICATION PRODUCTIVITY 10 RESEARCH IMPACT 9 BIBLIOMETRIC INDICATORS 9 CHOLESTEROL LOWERING 9 CITATION INDEX 9 CITATION INDEXES 9 CITATION PATTERNS 9 LOWERING TRIALS 9 PEER REVIEWERS 9 REFORM OPTIONS 9 RESEARCH ASSESSMENT 9 SCIENCE CITATION 9 SCIENTIFIC PERFORMANCE 8 BIG SCIENTOMETRICS 8 CITATION RATES 8 INTERNATIONAL SCIENTIFIC 8 QUALITATIVE EVALUATION 8 RESEARCH METHODS 8 SCIENTOMETRICS BIG 7 ASSESSMENT EXERCISE 7 CITATION DATA 7 PEER- REVIEW 7 RESEARCH BENEFITS 7 RESEARCH EVALUATION 7 SCIENCE POLICY 7 SCIENTIFIC COLLABORATION 7 UNITED-STATES SCIENCE 6 CITATION COUNTS 6 CONSUMER RESEARCH 6 EDITORIAL PEER-REVIEW 6 IMPACT ASSESSMENT 6 JOURNAL ARTICLES 6 LEDERBERG JOSHUA 6 MEDICINE VOL 6 NOBEL CLASS 6 PEER-REVIEWED JOURNALS 6 PEERLESS SCIENCE 6 QUANTITATIVE INDICATORS

CODE: THE NUMBER FOLLOWING EACH WORD PAIR REPRESENTS THE NUMBER OF TIMES THE WORD PAIR APPEARED IN ALL THE TITLES OF THE LITERATURE DATABASE

TABLE 11 TITLE TRIPLE WORD FREQUENCIES - RIA

115 CITATION- CLASSIC COMMENTARY 17 RESEARCH AND EVALUATION 11 EVALUATION AND RESEARCH 10 EVALUATION OF RESEARCH 9 CHOLESTEROL LOWERING TRIALS 9 CITATION AND OUTCOME 9 FREQUENCY OF CITATION 8 LIBRARY AND INFORMATION-SCIENCE 8 LITTLE SCIENTOMETRICS BIG 8 OPTIONS FOR PEER-REVIEW 8 OUTCOME OF CHOLESTEROL 8 SCIENCE AND TECHNOLOGY 8 SCIENTOMETRICS BIG SCIENTOMETRICS 7 INDICATORS IN HIGHER-EDUCATION 7 RESEARCH ASSESSMENT EXERCISE 6 INTENT OF PEER-REVIEWED 6 PEER-REVIEW AND UNITED-STATES 6 RELIABILITY OF PEER-REVIEW 6 REPRINTED FROM SCIENCE 6 RESEARCH IMPACT ASSESSMENT 6 SCIENTOMETRICS AND BEYOND 6 UNITED-STATES SCIENCE POLICY 5 APPLICATIONS FOR RESEARCH 5 COMMENTARY ON STUDIES 5 COMMUNICATION AND BIBLIOMETRICS 5 EVALUATION AND TEACHING 5 INQUIRY FOR LIBRARY-SCIENCE 5 INTERNATIONAL SCIENTIFIC COLLABORATION 5 METHODS AND APPLICATIONS 5 QUALITY OF CARE 5 REPRINTED FROM THEORETICAL 5 THEORETICAL MEDICINE VOL

TABLE 12 TITLE SINGLE WORD FREQUENCIES - RIA

432 COMMENTARY 390 RESEARCH 317 CITATION-CLASSIC 273 PEER-REVIEW 258 CITATION 158 SCIENCE 153 ANALYSIS 151 SCIENTIFIC 137 EVALUATION 121 CLASSIC 117 CITATION- 105 PERFORMANCE 87 INDICATORS 80 JOURNALS 72 BIBLIOMETRIC 72 CITATIONS 71 PRODUCTIVITY 70 IMPACT 66 LITERATURE 66 STUDY 61 ASSESSMENT 61 JOURNAL 54 DEVELOPMENT 54 PUBLICATION 53 REVIEW 52 QUALITY 49 INTRODUCTION 45 STUDIES 44 SCIENTOMETRICS 41 REPRINTED 41 VOL 39 INTERNATIONAL 38 METHOD 38 METHODS 37 PG 35 DATA 35 INFORMATION 35 PAPERS 33 STRUCTURE 33 THEORY 31 PATTERNS 31 POLICY 31 PROCESS 31 PUBLICATIONS 30 PSYCHOLOGY 30 SYSTEM 29 CASE 29 PRODUCTION 28 COMMUNICATION 28 EVALUATING 28 INFLUENCE 28 REPLY 28 SYSTEMS 28 TECHNOLOGY 27 BEHAVIOR 27 BIBLIOMETRICS 27 COMPARISON 27 SCIENTOMETRIC 26 CLINICAL 26 MEDICAL 25 ARTICLES 25 EFFECTS 25 HUMAN 25

TABLE 13 ABSTRACT DOUBLE WORD FREQUENCIES - RIA

152 PEER REVIEW 54 EVALUATION RESEARCH 52 CITATION INDEX 44 HEALTH CARE 44 PERFORMANCE INDICATORS 38 CITATION ANALYSIS 38 SCIENCE CITATION 34 UNITED STATES 30 SOCIAL SCIENCES 29 REVIEW PROCESS 26 ARTICLES PUBLISHED 25 INFORMATION SCIENCE 25 RESEARCH PRODUCTIVITY 23 IMPACT FACTOR 21 PAPERS PUBLISHED 21 SCIENTIFIC RESEARCH 20 RESEARCH PERFORMANCE 19 JOURNAL ARTICLES 19 SOCIAL SCIENCE 18 HIGHLY CITED 18 RESEARCH ASSESSMENT 18 TOTAL NUMBER 17 CITATION RATES 17 PAPER PRESENTS 17 RESEARCH OUTPUT 17 SCIENTIFIC PRODUCTIVITY 16 CITATION PATTERNS 16 EVALUATIVE RESEARCH 16 MENTAL HEALTH 15 CHEMICAL ENGINEERING 15 HEALTH PROMOTION 15 INFORMATION RETRIEVAL 15 PAPER DESCRIBES 15 SCIENTIFIC COMMUNITY 15 SCIENTIFIC LITERATURE 14

CODE: THE NUMBER FOLLOWING EACH WORD PAIR REPRESENTS THE NUMBER OF TIMES THE WORD PAIR APPEARED IN ALL THE ABSTRACTS OF THE LITERATURE DATABASE

TABLE 14 ABSTRACT TRIPLE WORD FREQUENCIES - RIA

36 SCIENCE CITATION INDEX 31 QUALITY OF CARE 24 NUMBER OF CITATIONS 23 SCIENCE AND TECHNOLOGY 18 LIBRARY AND INFORMATION 18 RESEARCH AND EVALUATION 16 PEER REVIEW PROCESS 13 NUMBER OF PUBLICATIONS 12 EVALUATION OF RESEARCH 12 NUMBER OF PAPERS 11 NUMBER OF AUTHORS 10 RESEARCH AND DEVELOPMENT 9 RESEARCH ASSESSMENT EXERCISE 8 EVALUATION AND RESEARCH 8 JOURNAL CITATION REPORTS 8 MAIN OUTCOME MEASURES 8 NUMBER OF ARTICLES 8 QUALITY OF LIFE 8 SCIENCES CITATION INDEX 8 SOCIAL SCIENCES CITATION 7 CITATION INDEX SCI 7 CITING AND CITED 7 PUBLISHED IN JOURNALS 7 QUANTITATIVE AND QUALITATIVE 7 SCIENTIFIC AND TECHNOLOGICAL 7 SCIENTISTS AND ENGINEERS 7 SOCIAL WORK JOURNALS 6 CORONARY HEART DISEASE 6 INSTITUTES OF HEALTH 6 JOURNAL OF CLINICAL 6 NATURE OF SCIENCE 6 PUBLICATION AND CITATION 6 RESEARCH AND ASSESSMENT

TABLE 15 ABSTRACT SINGLE WORD FREQUENCIES - RIA

1189 RESEARCH 386 CITATION 368 JOURNALS 359 STUDY. 343 ANALYSIS 338 DATA 319 SCIENTIFIC 313 SCIENCE 296 REVIEW 269 ARTICLES 268 JOURNAL 262 INFORMATION 252 PAPER 246 CITATIONS 239 AUTHORS 238 QUALITY 236 PAPERS 232 PERFORMANCE 228 NUMBER 226 EVALUATION 203 PUBLISHED 200 ARTICLE 196 STUDIES 195 SOCIAL 193 PEER 190 TWO 188 HEALTH 185 IMPACT 185 LITERATURE 182 BASED 165 PROCESS 161 FIELD 160 CARE 154 INDICATORS 152 SYSTEM 151 DEVELOPMENT 151 MODEL 148 PRODUCTIVITY 146 YEARS 145 CITED 143 PUBLICATIONS 135 ASSESSMENT 133 METHODS 128 MEDICAL 124 PUBLICATION 120 POLICY 119 COUNTRIES 115 FOUND 115 INDEX 114 AREAS 111 CLINICAL 110 FINDINGS 109 GROUP 109 TECHNOLOGY 105 DIFFERENCES 104 FACULTY 103 MEASURES 100 LEVEL 100

TABLE 10A TITLE DOUBLE WORD FREQUENCIES - JACS

56 TOTAL SYNTHESIS; 52 CHEM ENGN; MOLECULAR RECOGNITION; 38 PHYS CHEM; 35 RATE CONSTANTS; 34 MOLEC BIOL; 31 NUCLEAR MAGNETIC-RESONANCE; 28 STRUCTURAL CHARACTERIZATION; 28 THEORET CHEM; 26 EXPTL STN; 26 TRANSITION-METAL COMPLEXES; 24 PHARMACEUT SCI; 24 RAY CRYSTAL-STRUCTURE; 24 USA TRANSITION-METAL; 23 DIELS-ALDER REACTIONS; 22 RADICAL CATIONS; 22 X-RAY STRUCTURE; 21 MOLECULAR-ORBITAL METHODS; 21 RESONANCE RAMAN; 20 ENANTIOSELECTIVE SYNTHESIS; 20 STEREOSELECTIVE SYNTHESIS; 19 AB-INITIO STUDY; 19 ANORGAN CHEM; 19 BOND ACTIVATION; 19 IRON III; 19 MOLECULAR MECHANICS; 19 USA NUCLEAR-MAGNETIC-RESONANC; 18 REDUCTIVE ELIMINATION; 17 OXIDATIVE ADDITION; 16 ANTITUMOR ANTIBIOTICS; 16 CARBENE COMPLEXES; 16 II COMPLEXES; 16 MOLECULAR- STRUCTURE; 16 POTENTIAL-ENERGY SURFACE; 15 DIELS-ALDER REACTION; 15 ISOTOPE EFFECTS; 15 RUTHENIUM II; 14 CRYSTAL- STRUCTURE; 14 ELECTRON-TRANSFER REACTIONS; 14 III COMPLEXES; 14 PHOTOINDUCED ELECTRON-TRANSFER; 14 SELF-ASSEMBLED MONOLAYERS; 13 MOLECULAR CALCULATIONS; 13 RIBONUCLEOTIDE REDUCTASE; 13 SOLID-STATE NMR;

TABLE 11A TITLE TRIPLE WORD FREQUENCIES - JACS

13 USA NUCLEAR MAGNETIC-RESONANCE; 13 USA TRANSITION-METAL COMPLEXES; 11 COMPUTAT QUANTUM CHEM; 11 USA DIELS-ALDER REACTIONS; 10 ABSOLUTE RATE CONSTANTS; 10 SYNTHESIS AND CHARACTERIZATION; 10 USA CONVERGENT FUNCTIONAL-GROUPS; 9 EFFECTIVE CORE POTENTIALS; 9 SYNTHESIS AND STRUCTURE; 9 USA MOLECULAR-ORBITAL METHODS; 8 PREPARATION AND CHARACTERIZATION; 7 KINETIC ISOTOPE EFFECTS; 7 POTENT ANTITUMOR ANTIBIOTICS; 6 C-H BOND ACTIVATION; 6 ENHANCED FUNCTIONAL ANALOGS; 6 USA METAL-PROMOTED CYCLIZATION; 6 USA MOLECULAR MECHANICS; 6 USA RAY CRYSTAL-STRUCTURE; 5 ATOMIC BASIS SETS; 5 BASIS SETS FIRST-ROW; 5 GAUSSIAN BASIS FUNCTIONS; 5 IRON III COMPLEXES; 5 MARCUS INVERTED REGION; 5 MOLECULAR MECHANICS CALCULATIONS; 5 NONCOVALENT BINDING SELECTIVITY; 5 PREPARATION AND PROPERTIES; 5 SETS FIRST-ROW ATOMS; 5 STRUCTURE AND

REACTIVITY; 5 SYNTHESIS AND REACTIVITY; 5 USA MOLECULAR-HYDROGEN COMPLEXES; 4 AB- INITIO CALCULATIONS; 4 AB-INITIO MOLECULAR-ORBITAL STUDY; 4 ALPHA BETA- UNSATURATED; 4 ANTITUMOR ANTIBIOTIC CC-1065; 4 ASYMMETRIC TOTAL SYNTHESIS; 4 BRIDGED TETRAHYDROINDENYL LIGANDS; 4 CHIRAL TITANOCENE CATALYST; 4 CONICAL INTERSECTIONS IDENTICAL; 4 DENSITY FUNCTIONAL THEORY; 4 ELECTROCHEMISTRY OF SPONTANEOUSLY; 4 ENGLAND POTENTIAL-ENERGY SURFACES; 4 ESCHERICHIA-COLI RIBONUCLEOTIDE REDUCTASE; 4 EXPERIMENTAL AND THEORETICAL; 4 EXPERIMENTAL AND THEORETICAL-STUDY; 4 INTERSECTIONS IDENTICAL NUCLEI; 4 KINETIC AND MECHANISTIC; 4 MECHANISM OF ASSEMBLY; 4 MOLECULAR- STRUCTURE CRYSTAL-STRUCTURE; 4 OPENING METATHESIS POLYMERIZATION; 4 OXYGEN ATOM TRANSFER; 4 PHOTOINDUCED CHARGE TRANSFER; 4 PHOTOSYNTHETIC REACTION CENTER; 4 PLATINUM II COMPLEXES; 4 SCANNING TUNNELING MICROSCOPY; 4 SOLIDE INORGAN MOLEC; 4 SPONTANEOUSLY ADSORBED MONOLAYERS;

TABLE 12A TITLE SINGLE WORD FREQUENCIES - JACS

2218 CHEM; 2042 USA; 613 COMPLEXES; 393 SYNTHESIS; 274 JAPAN; 274 REACTIONS; 237 CHEMISTRY; 213 BIOCHEM; 195 STRUCTURE; 189 DERIVATIVES; 183 COMPLEX; 182 REACTION; 177 SPECTROSCOPY; 168 CANADA; 166 NY; 165 MECHANISM; 159 NMR; 153 BINDING; 153 MOLECULAR; 150 MA; 148 GERMANY; 146 MOLEC; 145 ORGAN; 138 ACID; 136 II; 132 IL; 129 GAS-PHASE; 127 CAMBRIDGE; 127 FAC; 126 BOND; 126 PHYS; 124 DNA; 123 MOLECULES; 121 LIGANDS; 120 MODEL; 120 RESONANCE; 116 REACTIVITY; 115 FRANCE; 115 TX; 115 VOL; 114 FORMATION; 114 IONS; 113 CO; 113 CRYSTAL-STRUCTURE; 111 STUDY; 110 WATER; 107 RECOGNITION; 107 SCH; 105 CHARACTERIZATION; 104 PROTEINS; 101 KU;

TABLE 13A ABSTRACT DOUBLE WORD FREQUENCIES - JACS

356 KCAL MOL; 165 AB INITIO; 139 SPACE GROUP; 117 RATE CONSTANTS; 84 TRANSITION STATE; 81 H-1 NMR; 80 KJ MOL; 73 ELECTRON TRANSFER; 71 ANGSTROM BETA; 67 X-RAY DIFFRACTION; 64 NMR SPECTROSCOPY; 64 ROOM TEMPERATURE; 63 GROUND STATE; 62 AQUEOUS SOLUTION; 57 GROUP P2; 56 FREE ENERGY; 55 HYDROGEN BONDS; 55 INITIO CALCULATIONS; 55 MOLECULAR ORBITAL; 53 CHEMICAL SHIFT; 53 CRYSTAL STRUCTURE; 53 POTENTIAL ENERGY; 53 PROTON TRANSFER; 53 RATE CONSTANT; 52 ANGSTROM ALPHA; 52 DOUBLE BOND; 51 HYDROGEN BONDING; 50 DOUBLE DAGGER; 49 DEGREES BETA; 49 GAS PHASE; 47 DEGREES GAMMA; 46 ISOTOPE EFFECTS; 44 EXCITED STATE; 43 CRYSTAL STRUCTURES; 42 HYDROGEN BOND; 42 RADICAL CATION; 40 ACTIVE SITE; 40 SOLID STATE; 40 TRANSITION STATES; 39 FE III; 39 GOOD AGREEMENT; 39 MASS SPECTROMETRY; 39 MONOCLINIC SPACE; 39 NMR SPECTRA; 38 CHEMICAL SHIFTS; 38 FORCE FIELD; 38 MOLECULAR MECHANICS; 35 ISOTOPE EFFECT; 35 TEMPERATURE DEPENDENCE; 34 BASE PAIRS; 34 C-13 NMR; 34 HYDROGEN ATOM; 33 ENERGY SURFACE; 33 EXPERIMENTAL DATA; 33 RADICAL CATIONS; 32 ACTIVATION ENERGY; 32 AMINO ACID; 31 BASIS SETS; 31 DNA CLEAVAGE; 31

ELECTRONIC STRUCTURE; 31 ET AL; 31 MOLECULAR DYNAMICS; 31 RING OPENING; 30 IRON III; 30 KINETIC ISOTOPE; 30 PREVIOUSLY REPORTED; 30 X-RAY CRYSTALLOGRAPHY; 29 METAL IONS; 28 DELTA DELTA; 28 EPR SPECTRA; 28 SIDE CHAIN; 27 ELECTRON DENSITY; 27 EXCITED STATES; 27 ORBITAL CALCULATIONS; 27 RESONANCE RAMAN; 26 BASIS SET; 26 CRYSTAL DATA; 26 FREE ENERGIES; 26 SIDE CHAINS; 26 VIBRATIONAL FREQUENCIES; 25 FE II; 25 INITIO MOLECULAR; 25 INTERSYSTEM CROSSING;

TABLE 14A ABSTRACT TRIPLE WORD FREQUENCIES - JACS

57 SPACE GROUP P2; 53 AB INITIO CALCULATIONS; 38 MONOCLINIC SPACE GROUP; 35 LEVEL OF THEORY; 29 POTENTIAL ENERGY SURFACE; 27 MOLECULAR ORBITAL CALCULATIONS; 25 AB INITIO MOLECULAR; 23 KINETIC ISOTOPE EFFECTS; 22 H-1 NMR SPECTROSCOPY; 22 INITIO MOLECULAR ORBITAL; 21 TRICLINIC SPACE GROUP; 17 ION CYCLOTRON RESONANCE; 17 MOLECULAR MECHANICS CALCULATIONS; 17 VAN DER WAALS; 15 AGREEMENT WITH EXPERIMENT; 15 H-1 NMR SPECTRA; 15 INTERPRETED IN TERMS; 14 AB INITIO METHODS; 14 DETERMINED BY X-RAY; 14 ELECTRON PARAMAGNETIC RESONANCE; 14 EXPLAINED IN TERMS; 13 KCAL MOL RESPECTIVELY; 13 SINGLE-CRYSTAL X-RAY DIFFRACTION; 13 SPACE GROUP C2; 12 AGREEMENT WITH EXPERIMENTAL; 12 CP RH CO; 12 DENSITY FUNCTIONAL THEORY; 12 DISCUSSED IN TERMS; 12 LASER FLASH PHOTOLYSIS; 12 LEVELS OF THEORY; 12 NUCLEAR MAGNETIC RESONANCE; 12 SECOND-ORDER RATE CONSTANTS; 11 DELTAH DOUBLE DAGGER; 11 H-1 AND C-13; 11 HEATS OF FORMATION; 11 ORDERS OF MAGNITUDE; 11 ORTHORHOMBIC SPACE GROUP; 11 SYSTEM SPACE GROUP; 10 AB INITIO QUANTUM; 10 AMINO ACID RESIDUES; 10 CALF THYMUS DNA; 10 CHARACTERIZED BY X-RAY; 10 DELTAS DOUBLE DAGGER; 10 FOURIER TRANSFORM ION; 10 HYDROGEN ATOM TRANSFER; 10 MOLECULAR DYNAMICS SIMULATIONS; 10 PREPARED AND CHARACTERIZED; 10 SINGLE AND DOUBLE; 10 SINGLE CRYSTAL X-RAY; 10 TRANSFORM ION CYCLOTRON; 10 X-RAY CRYSTAL STRUCTURES;

TABLE 15A ABSTRACT SINGLE WORD FREQUENCIES - JACS

792 REACTION; 710 ANGSTROM; 620 TWO; 617 DEGREES; 583 COMPLEXES; 526 BOND; 506 STRUCTURE; 500 ENERGY; 498 COMPLEX; 485 MOL; 479 OBSERVED; 465 CO; 444 GROUP; 424 STATE; 416 FOUND; 412 FORMATION; 398 REACTIONS; 371 KCAL; 367 NMR; 354 CALCULATIONS; 354 MOLECULAR; 346 BINDING; 344 DATA; 339 RATE; 332 ELECTRON; 331 ACID; 327 FORM; 321 II; 319 STRUCTURES; 306 ION; 297 RING; 297 TRANSFER; 293 RADICAL; 292 HYDROGEN; 290 EFFECTS; 288 DETERMINED; 288 SOLUTION; 287 SIMILAR; 285 SPECTRA; 283 DELTA; 278 MODEL; 267 TEMPERATURE; 264 ADDITION; 262 MOLECULES; 259 SPECIES; 258 DNA; 253 COMPOUNDS; 253 METAL; 251 TRANSITION; 250 BETA; 247 IONS; 246 ANALYSIS; 246 SURFACE; 237 VALUES; 229 CONSTANTS; 229 LIGAND; 228 SOLVENT; 227 WATER; 226 EFFECT; 226 PRODUCTS; 225 PH; 223 GROUPS; 222 MECHANISM; 221 CRYSTAL; 220 FE; 220 X-RAY; 217 STUDIED; 216 INTERACTIONS; 215 ENERGIES; 215 STUDIES; 214 CHEMICAL; 214 FORMED; 212 HIGH; 211 RESPECTIVELY; 210

EXPERIMENTAL; 209 INTERMEDIATE; 207 CALCULATED; 204 RELATIVE; 203 CORRESPONDING; 200 ALPHA;

THEME RELATIONSHIPS

To obtain the theme and subtheme relationships, a phrase proximity analysis is performed about each theme phrase. Typically, forty to sixty multi-word phrase themes are selected from a multi-word phrase analysis of the type shown above. For each theme phrase, the frequencies of words within +-50 words of the theme phrase for every occurrence in the full text are computed. A phrase frequency dictionary is constructed which shows the phrases closely related to the theme phrase. Numerical indices are employed to quantify the strength of this relationship. Both quantitative and qualitative analyses of each phrase frequency dictionary (hereafter called cluster) yield those subthemes closely related to the main cluster theme.

Then, threshold values are assigned to the numerical indices. These indices are used to filter out the most closely related phrases to the cluster theme (e.g., see the example (TABLE 16-CITATION-ABSTRACT DATABASE) following this section for part of a typical filtered cluster from the study).

Because of space limitations in this section, only two themes were chosen for the RIA phrase proximity analysis, and one theme for the JACS phrase proximity analysis. Peer review was one obvious high frequency RIA theme. Citation was chosen as the other RIA theme because of its high frequency, although Bibliometrics could have been an appropriate alternate theme. Complexes was chosen as the JACS theme, while Reaction could have been an equally appropriate theme.

The full text database was split into two databases. One was the abstract narrative, and it was hoped that performing the phrase proximity analysis on this database would yield mainly topical theme relationships. The other database consisted of records (one for each published paper) containing four fields: author(s), title, journal name, author(s) institutional address(es). It was hoped that performing the phrase proximity analysis on this database would yield not only topical theme relationships from the proximal title phrases, but also relationships between technical themes and authors, journals, and institutions.

TABLE 16

Theme phrase "CITATION" - ABSTRACT DATABASE - SORT BY Eij

```
.Cij...Ci........Ii........Ij.......Eij.....CLUSTER.MEMBER
...............(Cij/Ci)..(Cij/Cj)..(Ii*Ij)....

.150...386.......0.389.....0.389....0.1510...CITATION..
.137...368.......0.372.....0.355....0.1321...JOURNALS..
.106...246.......0.431.....0.275....0.1183...CITATIONS.
.107...268.......0.399.....0.277....0.1107...JOURNAL...
..94...236.......0.398.....0.244....0.0970...PAPERS....
```

..65...115.......0.565.....0.168....0.0952...INDEX.....
..70...145.......0.483.....0.181....0.0875...CITED.....
..91...269.......0.338.....0.236....0.0798...ARTICLES..
..93...313.......0.297.....0.241....0.0716...SCIENCE...

CODE:

Cij IS CO-OCCURRENCE FREQUENCY, OR NUMBER OF TIMES CLUSTER MEMBER APPEARS WITHIN +-50 WORDS OF CLUSTER THEME IN TOTAL TEXT;
Ci IS ABSOLUTE OCCURRENCE FREQUENCY OF CLUSTER MEMBER;
Cj IS ABSOLUTE OCCURRENCE FREQUENCY OF CLUSTER THEME;
Ii, THE CLUSTER MEMBER INCLUSION INDEX, IS RATIO OF Cij TO Ci;
Ij, THE CLUSTER THEME INCLUSION INDEX, IS RATIO OF Cij TO Cj,
AND Eij, THE EQUIVALENCE INDEX, IS PRODUCT OF INCLUSION INDEX BASED ON CLUSTER MEMBER Ii (Cij/Ci) AND INCLUSION INDEX BASED ON CLUSTER THEME Ij (Cij/Cj).

In the following figures, the underlined topic is the cluster theme. The cluster members were segregated by their values of Inclusion Indices (Ij and Ii), but due to space limitations, only the summary relational results are presented. Ij is the ratio of Cij to Cj, and is the Inclusion Index based on the theme phrase. Ii is the ratio of Cij to Ci, and is the Inclusion Index based on the cluster member. The dividing points between high and low Ij and Ii are the middle of the"knee" of the distribution functions of numbers of cluster members vs. values of Ij and Ii. All cluster members with Ij greater than or equal to 0.1 were defined as having high Ij. All cluster members with Ii greater than or equal to 0.5 were defined as having high Ii.

A high value of Ij means that, whenever the theme phrase appears in the text, there is a high probability that the cluster member will appear within +-50 words of the theme phrase. A high value of Ii means that, whenever the cluster member appears in the text, there is a high probability that the theme phrase will appear within +-50 words of the cluster member.

Phrases in the category HIGH Ij HIGH Ii are coupled very strongly to the theme phrase. Whenever the theme phrase appears, there is a high probability that the cluster member will be physically close. Whenever the cluster member appears, there is a high probability that the theme phrase will be physically close. Whenever either word appears in the text, the other will be physically close.

Consider phrases located under the heading HIGH Ij LOW Ii in Tables 17 and 18. Whenever the cluster member appears in the text, there is a low probability that it will be physically close to the theme phrase. Whenever the theme phrase appears in the text, there is a high probability that it will be physically close to the cluster member. This type of situation occurs when the frequency of occurrence of the cluster member Ci is substantially larger than the frequency of occurrence of the theme phrase Cj, and the cluster member and the theme phrase have some related meaning.

Single word phrases have absolute frequencies of an order of

magnitude higher than double word phrases. Thus, the phrases under the heading HIGH Ij LOW Ii are typically high frequency single words. They are related to the theme phrase but much broader in meaning than the theme phrase. A small fraction of the time that these broad single words appear, the more narrowly defined double word phrase theme will appear physically close. However, whenever the narrowly defined double word phrase theme appears, the broader related single word cluster member will appear. The phrases under this heading can also be viewed as a higher level taxonomy of technical disciplines related to the theme.

Consider phrases located under the heading LOW Ij HIGH Ii. Whenever the cluster member appears in the text, there is a high probability that it will be physically close to the theme phrase. Whenever the theme phrase appears in the text, there is a low probability that it will be physically close to the cluster member. This type of situation occurs when the frequency of occurrence of the cluster member Ci is substantially smaller than the frequency of occurrence of the theme phrase Cj, and the cluster member and the theme phrase have some related meaning. Thus, the phrases under the heading LOW Ij HIGH Ii tend to be low frequency double and triple word phrases, related to the theme phrase but very narrowly defined.

A large fraction of the time that these very narrow double and triple word phrasesappear, the relatively broader double word phrase theme will appear physically close. However, a small fraction of the time that the relatively broad double word phrase theme appears, the more narrow double and triple word phrase cluster member will appear. This grouping has the potential for identifying "needle-in-a-haystack" type thrusts which occur infrequently but strongly support the theme when they do occur. One of many advantages of full text over key or index words is this illustrated ability to retain low frequency but highly important phrases, since the key word approach ignores the low frequency phrases.

TABLE 17 - RIA

PEER REVIEW

The first grouping analyzed is the BLOCK database; low Ii high Ij. The words describe the more generic associations with PEER REVIEW. The major journals whose RIA articles tend to focus on peer review are shwn to include SCIENCE, NATURE, and BEHAVIORAL AND BRAIN SCIENCES. The major countries associated with peer review are USA and ENGLAND. The major users of peer review in this database tend to represent the medical community (MEDICAL; MEDICAL ASSOCIATION; SCH MED; MD). In summary, peer review has major emphasis in America and England, is featured in the major journals of Science, Nature, and Behavioral and Brain Sciences, and is employed widely in the medical community.

The second grouping analyzed is the BLOCK database; high Ii low Ij. The words describe the more specific associations with PEER REVIEW. Authors who focus on peer review are shown to include CHUBIN, HACKETT, CICCHETTI, RUBIN, TRACEY, LOCK, and DICKSON.

Journals closely associated with peer review in this database include JOURNAL OF CHILD NEUROLOGY, TECHNOLOGY REVIEW, JOURNAL OF PSYCHIATRY, ANGEWANDTE CHEMIE INTERNATIONAL, and BEHAVIORAL AND BRAIN SCIENCES. Institutions which appear often with peer review include JOHNS HOPKINS UNIV, YALE UNIV, SUNY-STONY BROOK, and NEW ZEALAND UNIV. Subthemes related to peer review include REFORM OPTIONS, MANUSCRIPT AND GRANT SUBMISSIONS, INTERNAL AND EXTERNAL STANDARDS, SCIENCE POLICY, PERFORMANCE REVIEW, REFEREES, QUALITY ASSESSMENT, QUALITY ASSURANCE, and RELIABILITY.

The third grouping analyzed is the ABSTRACT database; low Ii high Ij. The generic related themes from this database include the validity of the peer review process (PROCESS, CRITERIA, QUALITY, OBJECTIVE, RELIABILITY), the journal focus of peer review (MANUSCRIPTS, AUTHORS, JOURNALS, ARTICLES, EVALUATION), and the medical focus of peer review (HOSPITAL, HEALTH, MEDICAL, CLINICAL).

The fourth grouping analyzed is the ABSTRACT database; high Ii, low Ij. Specific themes include those related to process performance and quality (DEFICIENCIES, GRIEVANCES, BLINDED PEER REVIEW, NON-BLINDED PEER REVIEW, FOG INDEX, CONTROL GROUP, SHORTCOMINGS, READIBILITY), those related to the uses and purposes of peer review (RESEARCH SELECTION, IMPACT EVALUATION, QUALITY ASSESSMENT, OVERSIGHT, AUDIT, RESEARCH IMPACT), those related to the focus on selecting journal publications (EDITORIAL PROCESSES, SELECTION REVIEW, PUBLISHED IN JOURNALS, MANUSCRIPTS), and those related to the medical focus (TRAUMA CENTER, AMBULATORY CARE, CAESAREAN SECTIONS, MEDICARE, PRIMARY CARE, PERINATAL).

CITATION

The fifth grouping analyzed is the BLOCK database; low Ii high Ij. The words describe the more generic associations with CITATION. The major countries appear again to be the USA and ENGLAND; The major journal appears to be CURRENT CONTENTS, the major author appears to be GARFIELD, and the major institution appears to be INST-SCI-INFORMAT. These results show the sensitivity of the conclusions to the theme phrases chosen for the proximity analysis. The inclusion of citation classic commentaries in the database gave heavy weighting to CURRENT CONTENTS in which they appeared. Had BIBLIOMETRICS been chosen as a theme word, then <u>in addition</u> journals such as SCIENTOMETRICS would have appeared prominently, as would institutions such as HUNGARIAN ACADEMY OF SCIENCES and CHI-RES-INC, and authors such as NARIN and BRAUN.

The sixth grouping analyzed is the BLOCK database; high Ii low Ij. The words describe the more specific associations with CITATION. The authors closely associated with citations include GARFIELD, BURCHINSKY, DUPLENKP, HARGENS, WELLJAMSDOROF, and BOTT. The journals associated with citations include AMERICAN PSYCHOLOGIST, METEORITICS, CHEMICKE LISTY, SOUTH AFRICAN JOURNAL OF SCIENCE, AMERICAN JOURNAL OF ROENTGENOLOGY, SCIENCE TECHNOLOGY AND HUMAN VALUES. Institutions associated with citations include INST-SCI-INFORMAT, INST GERONTOL-KIEV, UNIV OF ILLINOIS, and UNIV OF MICHIGAN. Subthemes related to citation include COUNTS, RATES FREQUENCY, RANKINGS, INDEXES, LINKS,

HIGH IMPACT RESEARCH, IMPACT FACTOR, JOURNAL ARTICLES, PUBLICATIONS, CHAPTERS.

The seventh grouping analyzed is the ABSTRACT database; low Ii high Ij. The generic related themes from this database include types of documents cited (PAPERS, ARTICLES, PUBLICATIONS), characterization of material cited (RESEARCH, SCIENCE, LITERATURE), and yields from citations (ANALYSIS, PATTERNS, INFORMATION, DATA).

The eighth grouping analyzed is the ABSTRACT database; high Ii, low Ij. Specific themes include those related to citation focus areas (CITATION INDEX DATABASE, CITATION MATRIX, CITATION STUDIES, CITATION RATE, CITATION COUNTS, JOURNAL CITATION REPORTS, MEDIAN CITATION, CITATIONS PER ARTICLE, CITATION HISTORY, CITATION PROCESS, CITATION RETRIEVAL, CITATION IMPACT, CITATION FREQUENCY), citation analysis techniques (MEDIAN CITATION, MEAN CITATION, AVERAGE CITATION, MEAN VALUE FUNCTION, BIBLIOGRAPHIC COUPLING, ANALYSIS OF CITATIONS, LOGLINEAR, POISSON PROCESS, RELATIVE INDICATORS, COUNTS, COCITATION), outputs of citation techniques (RESEARCH FRONTS, HIGHLY CITED PAPERS, MAPPINGS), and specific technical areas analyzed (DERMATOLOGY, RADIOLOGY, HEART DISEASE, MARINE BIOLOGY, SAFETY SEATS, CAPITAL PUNISHMENT, AND ASTRONOMERS).

TABLE 18 - JACS

COMPLEXES

The first grouping analyzed is the BLOCK database; low Ii high Ij. The words describe the more generic associations with COMPLEXES. The major countries associated with research into COMPLEXES are USA, JAPAN, CANADA, ITALY, FRANCE, GERMANY, SPAIN, ENGLAND, and SWITZERLAND. The major states in the US associated with research into COMPLEXES are NY, MA, CA, IL, MO, DE, GA, PA, TX, NJ, MI, FL, and MN. The major research institutions associated with COMPLEXES are STANFORD, BERKELEY, EMORY, CALTECH, DELAWARE, DUPONT, and NORTHWESTERN. The major types of COMPLEXES researched include TRANSITION-METAL, IRON, RUTHENIUM, MOLYBDENUM, RHODIUM, TUNGSTEN, and PALLADIUM. The major analytical techniques associated with COMPLEXES include X-RAY, SPECTROSCOPY, NMR, and MASS-SPECTROMETRY. The major phenomena researched associated with COMPLEXES include SYNTHESIS, REACTIONS, CRYSTAL STRUCTURE, REACTIVITY, ELECTRON TRANSFER, ACTIVATION, POLYMERIZATION, CLUSTERS, CATALYSIS, OXIDATION, BINDING, and INSERTION.

The second grouping analyzed is the BLOCK database; high Ii low Ij. The words describe the more specific associations with COMPLEXES. Organizations closely associated with COMPLEXES research include SEARLE, HOKKAIDO-UNIV, KYOTO-UNIV, UNIV-PARMA, MERCK-SHARP, LOS-ALAMOS-NATL-LAB, UNIV-LAUSANNE, EMORY-UNIV, UNIV-DELAWARE, BERKELEY, UNIV-BARCELONA, UNIV-STRASBOURG, UNIV-SYDNEY, UNIV-MISSOURI, UNIV-ZARAGOZA, TEXAS A&M, UNIV-CHICAGO, UNIV-FLORIDA, AND BROOKHAVEN-NATL-LAB. Authors closely associated with COMPLEXES include SOLARI-E, FLORIANI-C, HEINEKEY-DM, COLLMAN-JP, and GOULD-IR.

This grouping clearly emphasizes an institutional focus of where research is conducted. Both industrial concerns and academic

facilities are emphasized, roughly equally. Significant themes seem to be, as expected, synthesis and characterization of complexes, but with a curious attention to fixing gases (MOLECULAR OXYGEN, HYDROGEN, OR CARBON MONOXIDE) within the complex, perhaps as one step in a catalysis reaction. Indeed, several of the papers in this grouping focus on 'reactive' complexes which could clearly be related to catalytic activity. It is likely that this group focuses heavily on catalysis as an overall theme.

The third grouping analyzed is the ABSTRACT database; low Ii high Ij. The generic related themes from this data base include understanding the actual structure of complexes, often by application of instrumental techniques (NUCLEAR MAGNETIC RESONANCE, X-RAY DIFFRACTION, ULTRA VIOLET OR INFRARED SPECTROSCOPY, others), an apparent extended examination of copper and iron complexes, and a weak reference to potential catalysis. There seems to be less emphasis on the actual formation (synthesis) of the complexes in this grouping.

The fourth grouping analyzed is the ABSTRACT database; high Ii, low Ij. Specific themes include those related to formation (synthesis) of a broad spectrum of metal complexes (focus on metals such as the platinum group, iron, nickel, copper) many of which appear to include multi-metal atom centers, (e.g. Pt-Pt) and even mixed multi-metal atom centers (e.g. Pt-Ir), and an emphasis on metal complexes involving carbon monoxide as a ligand, as well as some emphasis on unusual carbon-based ligands (e.g. per flourinated species). This version of the data base clearly seems to focus on the chemistry (esp. synthesis) of metal complexes.

The data base shows that the most prolific JACS authors were Schleyer, Rheingold, Boger and Trost, who published a total of 49 papers in 1994. These authors published extensively on focused themes, research topics their groups likely have pursued for several years before, and after, 1994. Specifically, Schleyer examined in depth synthesis complexes of alkali metals (e.g. sodium), a very unusual topic as alkali metals in general form complexes only rarely, as well applied computer based technology to elucidate the structure of such comples. Rheingold's group published extensivly on complexes involving metal-rutal bonds, and multi-metal atom clusters in catatopic systems. Boger, alone among the prolific authors, focused on bio-active molecules and their synthesis and reactivity as a function of structure. Trost, and his associates, appeared to examine transition metal catalysis of traditional, well characterized organic system reaction such as the Diehls-Alder reaction (which involves no metal species). In general, it is clear that the four authors are publishing heavily in broad areas of contemporary organic metallic chemistry: synthesis catalysis, structure and mechanism determination, and metal-mediation of bio-active molecules. Indeed, it is clear that these authors are defining the direction of these themes by their prolific research and publication programs.

CONCLUSIONS AND APPLICATIONS

This section has provided maps of the RIA and JACS Chemistry

fields, although only a small fraction of the raw data has been presented. A Competitive Intelligence (CI) professional who has interest in these fields has many options for proceeding further from the map, depending on this person's specific interests. For example, if the analyst wanted to understand the intellectual foundations of RIA or JACS Chemistry, then a reading of the most highly cited papers would be an excellent starting point. If the analyst wanted to overview the current literature, then two approaches are available. The comprehensive literature survey used as the database for the RIA analysis and reproduced in the back of this Handbook is one avenue. Another is to peruse the journals which contain the highest frequency of recent publications. This latter approach is worthwhile since computerized search approaches don't always identify the full scope of related articles to the topic of interest, and journals which focus on such a topical area could yield a cornucopia of useful information through browsing.

If the analyst wants to contact experts in a particular thrust area or technique, then contact could be made with the specific individuals or the institutions identified with given techniques in the theme relationships section. If the analyst wants to generate a taxonomy of the S&T field based on the technical relationships used by the research performers, then the approaches described in Appendix I might prove helpful. If the analyst wants to utilize the literature to help identify promising research directions, then the approach described in Appendix II might prove useful. The key conclusion is that, starting from the raw data, the analyst can generate any cross-cutting relationships desired to proceed further in specific directions of personal interest.

APPENDIX I - GENERATION OF TAXONOMIES

TAXONOMIES

The different types of Database Tomography outputs allow different types of taxonomies, or classifications into component categories, to be generated. Such categorizations, anologous to the independent axes of a mathematical coordinate system, allow the underlying structure of a field to be portrayed more clearly, leading to more focused analytical and management analyses. There is a major difference between the taxonomy obtained by this approach and other taxonomies. The present taxonomy derives from the language and natural divisions of the database, and therefore database entries are easily categorized. Other taxonomies are usually generated top-down and usually attempt to force-fit database subjects into predetermined categories.

One of the advantages of the present full text approach, relative to the index or key word approach, is that many types of taxonomies can be generated: i.e., science, technology, institution, journal, person name, etc. Even within one of these categories, such as science, many types of taxonomies can be developed, depending on the interests of the analyst and the reason for the taxonomy. Two

separate types of taxonomies will be discussed here.

I - PHRASE FREQUENCY TAXONOMY

The first type of taxonomy derives from the phrase frequencies. The authors examined the phrase frequency outputs, then arbitrarily grouped the high frequency phrases into different, relatively independent, categories for which all remaining terms would be accounted. Two examples of taxonomies are presented: the first is from a study of research papers related to the utilization of near-earth space, and the second is from a study of reports from the Foreign Applied Sciences Assessment Center (FASAC) assessing different areas of applied research in the former Soviet Union.

EXAMPLE 1 - NEAR EARTH SPACE RESEARCH TAXONOMY

About 5500 research papers relating to utilization of near earth space were drawn from the SCI. Phrase frequencies were generated from the abstracts, and the high frequency phrases were arbitrarily categorized. These relatively independent categories consist of Space Platform (E.G., SATELLITE, SPACECRAFT), Satellite Function (E.G., MAPPING, TRACKING), Satellite Type (E.G., GEOSAT, LANDSAT), Measuring Instrument (E.G., RADIOMETER, MICROWAVE LIMB SOUNDER), Region Examined (E.G., SEA, UPPER ATMOSPHERE), Location Examined (E.G., NORTH ATLANTIC, SOUTHERN HEMISPHERE), Variable Measured (E.G., TEMPERATURE, SOIL MOISTURE CONTENT), Variable Derived (E.G., RADIATION BUDGET, GENERAL CIRCULATION PATTERN), Analytical Tool (E.G., DATA PROCESSING, LEAST SQUARES), Products (E.G., TIME SERIES, TOTAL OZONE MAPPING), Space Environment (E.G., SOLAR WIND, MAGNETIC FIELD).

EXAMPLE 2 - FORMER SOVIET UNION APPLIED RESEARCH

About 35 full-length reports on the status of different areas of applied research in the Former Soviet Union were used as the database. Phrase frequencies were generated from the reports, and the high frequency phrases were arbitrarily categorized. An applied research taxonomy was generated. It consists of **Information** (IMAGE PROCESSING, PATTERN RECOGNITION, SIGNAL PROCESSING, ARTIFICIAL INTELLIGENCE, ETC.), **Physics** (SHOCK WAVES, RADIO WAVES, QUANTUM ELECTRON, MAGNETIC FIELD, CHARGED PARTICLE ACCELERATORS, OPTICAL PHASE CONJUGATION, ETC.), **Environment** (INTERNAL WAVES, OCEANIC PHYSICS, SEA SURFACE, IONOSPHERIC MODIFICATION, RADIO WAVE PROPAGATION, ETC.), and **Materials** (THIN FILM, COMPOSITE MATERIALS, FRACTURE MECHANICS, SOLID FUEL CHEMISTRY, STRENGTH MATERIAL, ETC.).

II - PHRASE PROXIMITY TAXONOMY

The second type of taxonomy derives from the phrase frequency and proximity analysis. From the phrase frequency analyses, fifty or sixty high frequency technical phrases were identified as pervasive themes. The next step was to group these high frequency phrases into

categories of related themes. A proximity analysis was done for each of these high frequency phrases. A phrase frequency dictionary, or cluster, was generated for each phrase. This cluster contained those phrases which were in close physical proximity to the pervasive theme throughout the text. The degree of overlap among clusters was computed. Clusters which shared more than a threshold number of common phrases were viewed as overlapping. These overlapping clusters were viewed as links in a chain, with the different chains being relatively independent. Each chain was then defined as a category of the larger taxonomy. For the study of applied research in the Former Soviet Union, the following taxonomy, or megacluster grouping, was generated.

The numbered themes (e.g., 1. IONOSPHERIC HEATING/ MODIFICATION) are the categories, or megaclusters. The component themes (e.g., *RADIO WAVE), preceded by an asterisk (*), are the clusters, or pervasive themes from the phrase frequency analysis.

1. IONOSPHERIC HEATING/ MODIFICATION
*RADIO WAVE
*WAVE PROPAGATION
*QUANTUM ELECTRON
*IONOSPHERIC MODIFICATION
*PHASE CONJUGATION

2. IMAGE/ OPTICAL PROCESSING
*PARALLEL PROCESSING
*PATTERN RECOGNITION
*IMAGE PROCESSING
*COMPUTER VISION
*DIGITAL COMPUTER
*ARTIFICIAL INTELLIGENCE
*DATA PROCESSING
*COMPUTER SCIENCE
*OPTICAL PROCESSING
*SPATIAL LIGHT MODULATOR
*SIGNAL PROCESSING
*LIQUID CRYSTAL
*LIGHT MODULATOR
*PROGRAMMING LANGUAGES
*INTEGRAL EQUATIONS

3. AIR-SEA INTERFACE
*SURFACE WAVE
*OCEANIC PHYSICS
*INTERNAL WAVE
*SEA SURFACE
*BOUNDARY LAYER
*ATMOS OCEANIC PHYS
*REMOTE SENSING

4. LOW OBSERVABLE
*LOW OBSERVABLE

*THIN FILM

5. EXPLOSIVE COMBUSTION
*KINETICS AND CATALYSIS
*SOLID FUEL
*EXPLOSION AND SHOCK
*SHOCK WAVE
*CHEMICAL PHYSICS
*EXPLOS SHOCK WAVE
*STRENGTH MATER
*FRACTURE MECHANICS
*COMPOSITE MATERIALS

6. PARTICLE BEAMS
*NEUTRAL BEAM
*PARTICLE ACCELERATOR
*ATOMIC ENERGY
*PLASMA PHYSICS
*ELECTRON BEAM
*CHARGED PARTICLE ACCELERATOR
*CHARGED PARTICLE

7. AUTOMATIC/ REMOTE CONTROL
*AUTOMATIC CONTROL
*REMOTE CONTROL

8. FREQUENCY STANDARDS
*FREQUENCY STANDARD
*HYDROGEN MASER

9. RADAR CROSS SECTION
*CROSS SECTION
*ELECTROMAGNETIC WAVE
*RADIO ENGINEERING

From the multiword frequency analysis, the science discipline taxonomy for the FASAC database was defined as Information, Physics, Environment, and Materials. In terms of the megaclusters, Information would encompass IMAGE/ OPTICAL PROCESSING and AUTOMATIC/ REMOTE CONTROL; Physics would encompass IONOSPHERIC HEATING/ MODIFICATION, PARTICLE BEAMS, FREQUENCY STANDARDS, and RADAR CROSS SECTION; Environment would encompass AIR-SEA INTERFACE; and Materials would encompass EXPLOSIVE COMBUSTION and LOW OBSERVABLE. Categorizing the database with the megacluster subcategories allows a re-interpretation of the FASAC database. FASAC can be viewed as a compendium of those aspects of FSU science of interest to the U. S. for strategic and military purposes rather than viewed as a microcasm of all of FSU science

APPENDIX II - IDENTIFICATION OF PROMISING RESEARCH DIRECTIONS

INTRODUCTION

This Appendix describes a literature-based approach to identifying opportunity-driven promising directions in science and technology. The method is generic to all fields of endeavor for which a literature exists, is dual use in the broadest sense, and has the potential to revolutionize how promising directions are identified. The approach is a computer-based analysis of the desired literatures using appropriate experts for data interpretation. The proposed procedure offers a potential quantum improvement over earlier related research efforts in the medical literature (10, 11). The technique would use the Database Tomography system described previously.

BACKGROUND

In the mid-1980s, Don Swanson showed that logical connections in the existing medical literature can be integrated to help identify promising medical research directions [Swanson, 1986]. His three literature-based investigations have hypothesized that 1) dietary fish oil would be helpful in treating Raynaud's Disease; 2) magnesium is important to migraine; and 3) there is a relationship between arginine and Somatomedin C. There has been medical corroboration of Swanson's discoveries [Gordon, 1986].

Gordon and Lindsay used computer-based tools to replicate and extend Swanson's work [Gordon, 1986]. A more detailed summary of their work, as well as additional improvements possible with the authors' approach, is in the Procedure section which follows. Basically, they used word frequency analysis to examine the literature of interest, they used the high frequency words or phrases to identify related intermediate literatures, and then used a combination of high frequency phrases and weak relations between the phrases to identify the promising research directions from the related literatures.

For example, they performed a phrase frequency analysis of the Raynaud's Disease (RD) literature, and found that BLOOD VISCOSITY was a crucial element in RD. They then performed a phrase frequency and weak phrase proximity (ratio of phrase appearance in BLOOD VISCOSITY literature to appearance in total medical literature) analysis of the BLOOD VISCOSITY literature. Their analyses confirmed Swanson's results, and showed that FISH OIL and EICOSAPENTAENOIC ACID (one of fish oil's main chemical constituents) offerred substantial promise as research directions. Experiments performed subsequent to Swanson's findings have confirmed these predicitions.

The authors believe this strong dependence on high frequency phrases and only latter stage employment of the weak proximity condition severely constrains the technique's potential. Based on the authors' database analyses of the past five years, it was found that the strong physical proximity of phrases in text is of equal importance to the occurrence frequency of those phrases when

constructing structural maps of science and technology. In fact, for identifying promising research and technology directions, strong phrase proximity may be far more important than phrase frequency. High frequency phrases tend to reflect both the obvious and the mainstream efforts, while low frequency phrases located in close proximity to phrases of topical interest have much greater chance of uncovering 'needles-in-a-haystack'. In addition, as was shown in a recent paper, the full power of the authors' analytic approach requires the use of both phrase frequency and strong phase proximity at every iterative step in the analysis [Kostoff, 1997f].

The author's approach uses the Database Tomography tools of phrase frequency analysis in conjunction with strong phrase proximity analysis. This allows identification not only the mainstream high-frequency relationships, but the less-explored low-frequency high-proximity relationships as well. This provides the capability to identify the most promising science and technology directions with the least restrictions.

PROCEDURE

The remainder of this section summarizes Gordon and Lindsay's work on literature-based discovery, and shows how the combination of Database Tomography and their approach would eliminate the major deficiencies in their present approach. This combined approach could have tremendous payoff in many technical and non-technical fields.

The initial summary of Gordon and Lindsay's work will focus on their example of Raynaud's Disease (RD). The objective of their approach is to find something in the published literature that will point to new directions for treating/ curing, etc. RD. They use the following approach. Search the literature (MEDLINE, in their particular case) to retrieve all documents which contain Raynaud* in the appropriate fields (560 documents). Using word frequency analysis (including different types of word frequency analysis statistics), identify high frequency terms related to RD.

For example, they find BLOOD is such a term. They then identify the subset of the Raynaud documents which contain blood-related terms (BLOOD FLOW, BLOOD VISCOSITY, PLATELET AGGREGATION, ETC.), and repeat the word frequency analysis on this subset (232 documents). They find that ideas related to BLOOD FLOW should be pursued further. In particular, they find that BLOOD VISCOSITY is related to BLOOD FLOW, is a possible cause of impaired flow, and is statistically prominent in its own right.

Here comes a crucial part of their approach. They go back into the literature, and search for all records related to BLOOD VISCOSITY, whether or not they are related to RD. After performing a word frequency analysis and a weak proximity analysis on this information retrieved, they prune the list of terms to 115 which they judge to be initial candidates for discovery. The details of the pruning are not relevant for what follows here. Of the 115 terms, they find that only 34 did not appear in the list of the original 560 Raynauds records. These 34 terms are what they call disjoint from Raynauds, and are therefore true candidates for discovery. They

finally arrive at FISH OIL, and EICOSAPENTAENOIC ACID (one of fish oil's main chemical constituents) as the discovery items.

The purpose of their study was to replicate Swanson's approach for identifying promising directions in medical research, done without computerized information retrieval techniques, ten years earlier. They did replicate, and they also show that follow-up medical research has corroborated Swanson's discoveries. Thus, their method and Swanson's appear to have great promise in mining the medical literature for promising new directions. What, then, are the deficiencies?

Their approach is based mainly on word frequency analysis, and the use of high frequency terms to guide promising directions. Only in the last step of their analysis do they employ a weak proximity analysis condition. Based on the authors' experience, high word frequencies tend to reflect mainstream research approaches heavily published in the literature. Use of high frequency terms at most stages of the analysis will effectively eliminate concepts, accepted or alternative, which have received little support in the past and are lightly represented in the literature.

What is required for a more complete computer-based analytical tool is a method that gives equal emphasis to low frequency terms as well as high frequency terms. In practice, the low frequency term analyzer would probably be more valuable for identifying promising opportunities. High frequency relationships tend to be more obvious, and probably many of these types of relationships are known without use of the computerized analysis. According to Gordon and Lindsay, Swanson was able to hypothesize the promising opportunities without the use of the computerized analysis. While high frequency relationships are useful in mapping structural relationships among science and technology disciplines, as has been shown with the Database Tomography efforts, it is the low frequency relationships which have the greater potential of finding the 'needles in a haystack'.

However, while there are relatively few high frequency relationships, and the analytical problem is relatively bounded, there are very large numbers of low frequency relationships. The problem becomes pragmatically intractable if no further conditions are placed on the low frequency relationships. The additional conditions on the low frequency relationships required to make the problem tractable derive from the word proximity analyses. Examine only those low frequency terms which are also strongly related to the dominant themes of the problem. In other words, examine those low frequency terms which have high inclusion indices (number of appearances within some domain around the dominant term/ number of appearances in the total text) relative to the dominant terms. Thus, whenever these low frequency terms appear in the text, they are located physically close to the dominant themes.

The Raynaud example will now be used to show how Database Tomography in conjunction with Gordon and Lindsay's method could have worked. Using DT, two major pathways could have been examined, where Gordon and Lindsay examined only one. For the first pathway, use Gordon and Lindsay's database and replicate, using word frequency

analysis, that BLOOD VISCOSITY appears important. Examine the BLOOD VISCOSITY literature further, as they did. Then, do a word frequency analysis of the BLOOD VISCOSITY literature, and identify the high frequency terms.

At this point, perform a strong word proximity analysis for BLOOD VISCOSITY on the retrieved blood viscosity literature. Identify (using the numerical indicators from the proximity analysis) those terms which, when they appear in the blood viscosity literature, are located physically close to BLOOD VISCOSITY. Thus, for argument's sake, FISH OIL may appear 100 times in the blood viscosity literature (and not in the RAYNAUD* literature; keep the requirement of disjointness), but in only 30 of those times does it appear physically close to BLOOD VISCOSITY. It would have an inclusion index of 30/100=.3. However, a potential low frequency term like VISUALIZATION may appear only 5 times in the BLOOD VISCOSITY literature (again, not in the RAYNAUD* literature), but in 4 of those times it appears physically close to BLOOD VISCOSITY. It would have an inclusion index of 4/5=.8.

Then, investigate both FISH OIL (high frequency and low inclusion) and VISUALIZATION (high inclusion and low frequency) further, with the use of the medical experts, for promising research directions.

For the second pathway, perform a strong word proximity analysis on the initial RD literature. Based on the results of this analysis, define a promising intermediate literature, analogous to the BLOOD VISCOSITY literature on the first pathway. Perform word frequency and strong proximity analyses on this intermediate literature, and interpret the data with the support of medical experts to arrive at (hopefully) further promising research directions.

IX-A. DATABASE TOMOGRAPHY FOR INFORMATION RETRIEVAL

This section includes contributions from DR. RONALD N. KOSTOFF, OFFICE OF NAVAL RESEARCH; MR. HENRY J. EBERHART, NAVAL AIR WARFARE CENTER, WEAPONS DIVISION CHINA LAKE; MR. DARRELL RAY TOOTHMAN, DSTI, INC.

ABSTRACT

This section describes an iterative full-text information retrieval approach using Database Tomography (DT) and Simulated Nucleation (SN). The method generates search terms from the language and context of the text authors, and is sufficiently flexible to apply to a variety of databases. It provides improvement to the search strategy and related results as the search progresses, not only adding relevant records to the information retrieved, but subtracting non-relevant records as well.

As shown previously in sections IV-C and IX, Database Tomography is an information extraction and analysis system which operates on textual databases. Its primary use to date has been to identify pervasive technical thrusts and themes, and the interrelationships among these themes and sub-themes, which are intrinsic to large textual databases. Its two main algorithmic components are multi-word phrase frequency analysis and phrase proximity analysis.

Simulated Nucleation, the name given to the form of Database Tomography adapted to information retrieval, derives in concept from the growth of materials. In Simulated Nucleation for information retrieval, a small core group of documents relevant to the topic of interest is identified. The main algorithmic components of Database Tomography, phrase frequency and phrase proximity analyses, operate on this core group of documents. Patterns of word combinations in existing fields are identified, new search term combinations which follow the newly identified patterns are generated, and the process is repeated. In addition, patterns of word combinations which reflect extraneous non-relevant material are identified, and search terms which have the ability to remove non-relevant documents from the database are inserted. Thus, Simulated Nucleation operates in a self-correcting cybernetic homeostatic mode, and continually expands the coverage and improves the quality of the core database. This iterative procedure continues until convergence is obtained, where relatively few new documents are found or few non-relevant documents are identified, even though new search terms are added. An application is described of developing, from the Science Citation Index, a database of journal articles focused on near-earth Space Science and Technology.

INTRODUCTION

Over the past decade, with the growth and expansion of electronic storage media, there has been a virtual explosion of data readily available. In particular, use of CD-ROMs and the

Internet have provided overwhelming data resources to the average user. Standard database search approaches tend to cast either too wide a net or too fine a net to make optimal use of this information. The central problem with most standard search approaches is that the analyst hypothesizes what the search terms should be in the context of the application, rather than uses the database to provide the search terms appropriate to the context in which they are actually imbedded. Even in those databases which provide an on-line dictionary of terms used (typically single word only), the analyst is unable to ascertain the context in which those words are employed, and therefore cannot predict if the theme of the article targeted by the search term used is the theme desired. The search approaches which try to approximate context better by weighting different search terms, and then using a figure of merit to select documents which effectively contain more and a wider variety of the weighted search terms, still have the limitations of being based on analyst hypotheses.

A high quality information retrieval approach should not only be able to yield the search terms from the language and context of the authors rather than from the language of the searcher, but should have other desireable properties. It should be able to work efficiently on a variety of different databases. Some databases have keywords; most don't. Some databases provide authors; some don't. Some databases provide references; some don't. Finally, analogous to a neural network's operation, a high quality information retrieval approach should be able to improve the search strategy and results as time proceeds. This section describes an information retrieval approach which has these desireable properties, and more.

BACKGROUND

As part of a larger project, the authors needed to perform a literature survey of published science and technology papers related to utilization of near-earth-space. A survey of the information retrieval literature to identify an efficient query concept produced very mixed results. Most of the information retrieval papers tended to be very abstract, contained little detail that would provide guidance in conducting an actual query, and appeared marginally related to the much less esoteric methods used by actual information retrieval practitioners (librarians, etc.). In addition, most of these published information retrieval papers focused on the use of search terms derived from extrinsic sources, rather from the language used by the database text authors. The authors of the present section felt that these deficiencies would probably limit the efficiency and comprehensiveness of the search process and final results.

Since the authors had been developing database analysis techniques based on Term Co-occurrences over the past few years, it was decided to see whether these techniques could be adapted and expanded to address the literature survey problem. To achieve the objective of developing the high quality information retrieval

approach whose properties were described in the previous section, the Term Co-occurrence retrieval component already developed by the authors would have to be embedded in a Relevance Feedback structure with Query Expansion. An ancillary objective was to develop and articulate this novel information retrieval approach such that it could easily be employed by real-world practitioners.

The remainder of this Background section outlines the major efforts that have been performed in Term Co-Occurrence, Co-Word Analysis, Query Expansion, and Relevance Feedback, and addresses some of their limitations. These four topics are not distinct, but have substantial overlap, and this is reflected in the historical survey.

TERM CO-OCCURRENCE AND CO-WORD ANALYSIS

Term Co-occurrence has its roots in co-word analysis and computational linguistics. Co-word analysis utilizes the proximity of words and their frequency of co-occurrence in some domain (sentence, paragraph, paper, etc.) to estimate the strength of their relationship. When applied to the literature in a technical field, co-word analysis allows a map of the relationship among technical themes to be constructed. A history of co-word analysis applied to research policy issues, its origins in computational linguistics, and its limitations due to previous dependence on the sole use of key words and index words, can be found in recent review articles and references [Kostoff, 1991d, 1992a, 1993c].

TERM CO-OCCURRENCE AND QUERY EXPANSION

Term Co-occurrence in information retrieval can be used to expand on an initial query, and the additional query terms allow the retrieval of relevant documents that would not have been retrieved with the initial query. These additional terms could also be used to remove irrelevant documents. Traditionally, this form of query expansion has been carried out by means of thesauri and controlled vocabularies. The construction of these is time-consuming and expensive. Additionally, these extra terms are analyst-generated, rather than generated from the phrases used in the searched database.

Studies related to the use of Term Co-occurrence in information retrieval can be traced back to at least the 1960s [Maron, 1960; Stiles; 1961; Lesk, 1969]. These early experiments demonstrated the potential of Term Co-occurrence data for the identification of search term variants, and eventually led to the conclusion that query expansion led to the greatest improvement in performance when the original query gave reasonable retrieval results, whereas expansion was less effective when the original query had performed badly. This is in accord with the Association Hypothesis: "If an index term is good at discriminating relevant from non-relevant documents then any closely associated index term is also likely to be good at this" [Van Rijsbergen, 1979].

More recent work on Query Expansion related to Term Co-

occurrence has been based on probabilistic models of the retrieval process and has tried to relax some of the strong assumptions of term statistical independence that normally need to be invoked if probabilistic retrieval models are to be used. Results have been mixed; it was not found possible to obtain consistent improvements in performance by the use of any of the query expansion methods [Croft, 1979; Robertson, 1976; Smeaton, 1983] . As will be shown later in this section, this has not been the experience of the authors, and may be due to the sole reliance by the authors on natural language expressions from the database for Query Expansion terms rather than utilization of external sources for these additional terms.

RELEVANCE FEEDBACK AND QUERY EXPANSION

Relevance Feedback is a controlled process for query reformulation. The main idea consists of choosing important terms, or expressions, attached to certain previously retrieved documents that have been identified as relevant by the users, and of enhancing the importance of these terms in a new query formulation [Salton, 1990] . Analogously, terms included in previously retrieved non-relevant documents could be deemphasized in any future query formulation.

Initially, the Relevance Feedback implementations were designed for queries and documents in vector form; i.e., query statements consisting of sets of possibly weighted search terms used without Boolean operators [Rocchio, 1971; Salton, 1971] . Since the 1980s, Relevance Feedback methods have been applied also to Boolean query formulations, where the process incorporates term conjuncts (derived from previously retrieved relevant documents) into revised query formulations [e.g., Salton, 1985]

More recently, Relevance Feedback approaches with probabilistic information retrieval based on document components have been incorporated into artificial neural networks [e.g., Kwok, 1995]. This approach recognizes the intrinsic relevance feedback operation of artificial neural networks, and the natural application to the information retrieval process. Performance with feedback improved substantially over the no feedback case.

Another important recent study, which has an important bearing on the present paper, focused on determining the retrieval effectiveness of search terms identified by users and intermediaries from retrieved items during term relevance feedback. Results show that terms selected from particular database fields of retrieved items during term relevance feedback (TRF) were more effective than search terms from the intermediary, database thesauri or users' domain knowledge during the interaction. The study concludes that more focus on the practice of database searching and on the origins of the terms used for the feedback process is necessary [Spink, 1995].

Also recently, use of local context analysis [Xu, 1996], which combines global analysis [Jing, 1994; Callan, 1995] and local feedback [Attar, 1977], has generated effective information

retrieval results. In this combined approach, noun groups are used as concepts and concepts are selected based on co-occurrence with query terms. Concepts are chosen from the top-ranked documents, similar to local feedback, but the best passages are used instead of whole documents. An algorithm is used to rank the concepts, and the query is then expanded.

The overwhelming majority of the reported Relevance Feedback studies for Query Expansion appear to have focused on the mathematical operations and cognitive aspects of the feedback process. While this focus has resulted in many of the process innovations and advances, it has been limited in eliminating the inconsistency of the Relevance Feedback process results. Relatively few innovative approaches have been applied to identifying more appropriate sources of expansion terms. The present section focuses mainly on the expansion term sources.

In the remainder of this section, the adaptation and utilization of Database Tomography for information retrieval (a process called Simulated Nucleation) is presented. Finally, an application of the procedure to generate a database of journal articles on the science and technology available for near-earth-space missions is described in detail.

UTILIZATION OF DATABASE TOMOGRAPHY FOR INFORMATION RETRIEVAL

Database Tomography applied to information retrieval has all the desireable qualities of the high quality information retrieval process listed in the Introduction, and more. It will operate on any textual database in any language. It requires text only, but will be enhanced with use of titles, keywords, references, etc. It works directly from the language of the authors of the database's contents, and improves the search strategy and product with time. Its value increases as the size of the desired retrieval increases.

Simulated Nucleation, the name given to the form of Database Tomography adapted to information retrieval, derives in concept from the growth of materials. A core nucleus is developed, the properties of this nucleus are identified, and then similar material is added onto the nucleus as time develops until the desired amount of material is obtained. The growth process is then terminated.

In Simulated Nucleation for information retrieval, the purpose is to provide a tailored database of retrieved documents, which contains all relevant documents from the larger literature, but which also contains a minimal amount of non-relevant documents. In the initial step of Simulated Nucleation, a small core group of documents relevant to the topic of interest is identified. An inherent assumption is then made that the word patterns and combinations in this core group would be found to occur in other relevant documents, and therefore these word patterns and combinations can be used to expand the search query. The main algorithmic components of Database Tomography, phrase frequency and phrase proximity analyses, operate on this core group of documents.

Patterns of word combinations in existing fields are identified,

new search term combinations which follow the newly identified patterns are generated, and the process is repeated. In addition, patterns of word combinations which reflect extraneous non-relevant material which may have been introduced are identified, and search terms which have the ability to remove non-relevant documents from the database are inserted. Thus, Simulated Nucleation operates in a self-correcting cybernetic homeostatic mode, and continually expands the coverage and improves the quality of the core database. This iterative procedure continues until convergence is obtained, where relatively few new documents or non-relevant documents are found even though new search terms are added.

APPLICATION OF SIMULATED NUCLEATION FOR INFORMATION RETRIEVAL

A) Database and Field Selection

A recent application of Simulated Nucleation will elucidate and clarify the above principles. It was desired to generate a compendium of journal articles on Space Science and Technology, with emphasis on near-earth space. The database generated would then be analyzed using the standard Database Tomography procedure [Kostoff, 1993f, 1994h, 1995e]. As a source for these articles, two major databases were employed: the Science Citation Index, which includes over 3200 research (mainly basic) journals, and the Engineering Compendex, which includes over 2600 research (mainly applied) and technology and engineering journals. The remainder of this paper describes the query of the Science Citation Index, since the Engineering Compendex query utilized the same approach.

For the present study, the relevant output fields for a given article from the Science Citation Index include: Author(s), title, journal, author(s) address(es), author's keywords, keywords plus, abstract, references, and related records. While most of the papers have most of the fields, not all papers have all fields. In terms of frequency of fields included, all papers obtained in the Space science and technology search seem to have a title and journal field, most have an author and address field, almost as many have an abstract field, roughly a similar amount have references and related records fields, and perhaps half have keyword fields.

B) Initialization of Database

The search was initialized on the Science Citation Index using some core search terms which would generate a group of papers which directly addressed the topics of interest. Based on previous experiments, the search term-field combination which had the highest probability of identifying relevant papers was selected initially. This combination consisted of near-earth-space-related multi-word phrases applied to the title and keyword fields (e.g., SATELLITE IMAG*, SATELLITE SENS*, SATELLITE OBSERVATION*, where * denotes the multi-character wildcard). Sixty search terms were used for the initialization, and this produced 401 unique journal articles, over 95 percent of which were considered as very relevant to the topical area of interest. Another approach was also tried

for the initialization. The purpose was to reduce the number of search terms, since previous searches with the same computer-database combination had resulted in operational problems as the number of search terms became very large. The term SATELLITE was used in the title and keywords, and 811 papers were identified, of which about 70 percent were near-earth-space related. About 20 word combinations were identified which reflected non-space related topics (e.g., SATELLITE VIRUS, SATELLITE AND DNA, SATELLITE CLINICS), and these word combinations were inserted into the title and keyword search queries after the NOT operator, which removed their parent documents from the database. The resultant 657 documents, 85 percent of which were space related, were used as the initial core database.

C) Iterative Query Process

At this point, the first iterative step of Simulated Nucleation was taken.

1) One database was constructed of the journal article titles, and another database was constructed of the abstracts.

2) The multi-word phrase frequency analysis component of Database Tomography was applied to each database, and the high frequency single word, adjacent double word, and adjacent triple word phrases in each database were extracted and ordered by decreasing frequency (e.g., MICROGRAVITY, ORBITAL DEBRIS, SYNTHETIC APERTURE RADAR).

3) The multi-word phrase proximity analysis component was applied selectively to each database. In particular, a few high frequency phrases from the phrase frequency analysis which had multiple meanings, one of which was space-related, were used as theme words about which a word frequency dictionary was constructed (e.g., SPACE, SATELLITE).

4) All the keywords for each paper were combined, and the list was sorted in order of decreasing frequency.

5) Based on parallel interpretation of the keywords, phrase frequency analysis and the phrase proximity analysis, different combinations of search procedures-fields were added to the search query.

5a) Additional space-related multi-word phrases were added to the keywords and title fields search (e.g., ORBITAL DEBRIS, EARTH ORBIT).

5b) Boolean combinations of phrases were added to the title and keyword field queries. These phrases had the property that individually they were not near-earth-space unique, but in combination they appeared much more relevant topically (e.g., SATELLITE AND IMAG*, SPACE AND OCEAN). This expansion into a Boolean search has positive and negative virtues. For those Boolean expressions derived from a multi-word phrase (e.g., SATELLITE IMAG*---->SATELLITE AND IMAG*), more topical papers can be retrieved because the Boolean query terms (SATELLITE AND IMAG*) are less restrictive compared to the parent multi-word phrase (SATELLITE IMAG*). On the other hand, removing the restrictions of close multi-word linkages also allows the possibility that non-

topical papers will be obtained.

One value of the phrase proximity analysis of the title field is that some estimate of the value of expanding a multi-word phrase query (SATELLITE SENSOR) into a Boolean query (SATELLITE AND SENSOR) can be extracted from the phrase proximity results. For example, consider the following case. Assume that SATELLITE is the theme of a phrase proximity analysis. Assume further that SATELLITE occurs 100 times in the total title database. In the word frequency dictionary constructed around the theme SATELLITE, assume that SENSOR occurs 100 times in the domain within fifty words of SATELLITE, which means that SENSOR occurs 100 times in the same title as SATELLITE. This means that the Inclusion index based on the theme word Ij (the number of occurrences of SENSOR within fifty words of SATELLITE divided by the total number of occurrences of SATELLITE in the database) is high. If Ij is low, there is little motivation to use the word combination in either form. Assume further that neither SATELLITE SENSOR or SATELLITE AND SENSOR were used in previous queries. Examine two limiting conditions.

In the first condition, the multi-word phrase SATELLITE SENSOR occurs 100 times in the domain within fifty words of SATELLITE. This means that whenever SATELLITE and SENSOR appear together in the title, they appear as the multi-word phrase SATELLITE SENSOR. In this situation, the pattern SATELLITE SENSOR is the one that has always occurred in the title of the relevant papers obtained so far, and the pattern SATELLITE AND SENSOR (where they are disconnected) is the one that has never occurred in the title of the relevant papers. Since the philosophy of Simulated Nucleation is to extrapolate from known patterns within relevant papers to obtain new search terms, then the pattern SATELLITE SENSOR would be used as a new search term for the title and (probably) keyword fields in the next query iteration.

In the second condition, the multi-word phrase SATELLITE SENSOR occurs zero times in the domain within fifty words of SATELLITE. This means that whenever SATELLITE and SENSOR appear together in the title, they never appear as the multi-word phrase SATELLITE SENSOR. This example covers two conditions: where a real multi-word phrase (SATELLITE SENSOR) has low frequency of occurrence, or where the two search terms never form a multi-word phrase (SATELLITE---SEA SURFACE TEMPERATURE. In this situation, the pattern SATELLITE AND SENSOR is the one that has always occurred in the title of the relevant papers obtained so far, and the pattern SATELLITE SENSOR is the one that has never occurred in the title of the relevant papers. Since the philosophy of Simulated Nucleation is to extrapolate from known patterns within relevant papers to obtain new search terms, then the pattern SATELLITE AND SENSOR would be used as a new search term for the title and (probably) keyword fields in the next query iteration. This query pattern identification procedure for the title field is extrapolateable to the abstract field for the case where the spacing between the query search terms can be controlled (term a within x words of term b).

A note of caution is required here. In the case where SATELLITE occurs 100 times in the title, SENSOR occurs 100 times in the domain within fifty words of SATELLITE, and SATELLITE SENSOR occurs 100 times in the domain within fifty words of SATELLITE, then the correct conclusion to be drawn is that for space-related papers, whenever SATELLITE and SENSOR occur together in the title, they occur as a word pair. However, in a general title search of all SCI papers, SATELLITE and SENSOR could co-occur theoretically in the title many times in non-space-related papers.

Another value of the phrase proximity analysis of the title field is that guidance is provided into expanding the search into specific areas beyond the realm of near-earth-space. For example, assume the proximity analysis shows that a close relationship exists between SATELLITE and MICROWAVE RADIOMETER. This combination could be added to the title and keyword search as a Boolean. Then, a title search of MICROWAVE RADIOMETER alone could be done to obtain information on the technology beyond its space applications. These expansion searches could be performed during the database analytic phase. This benefit of phrase proximity analysis for the title field may be extrapolated to the abstract field in the case where the spacing between the search term combination can be controlled.

5c) Additional space-related multi-word phrases were added to the abstract field search (e.g., ORBITAL DEBRIS, EARTH ORBIT).

5d) For databases where the spacing between the search terms could not be controlled in the abstract, Boolean search terms should not be added to the abstract field to broaden the query. Based on experiments performed on the title and abstract fields using word pairs (e.g., SATELLITE SENSOR) and their Boolean derivatives (e.g., SATELLITE AND SENSOR), it was found that while word pair queries on either field gave good results, and Boolean queries on the title and keywords gave good results, Boolean queries on the SCI abstract field with no spacing control between the terms introduced many non-space-related papers. These poor results were due to the individual terms being located sufficiently distant in the abstract that their contexts were different.

However, for databases which allow control of the spacing between the Boolean search terms (e.g., SATELLITE within 10 words of SENSOR), then a Boolean query could be used for the abstract. Both the SCI and Engineering Compendex databases allow combinations of terms to be limited to the same sentence in the abstract, which places them in the same context. In selecting which combinations of terms to use for the query, priority should be given to those terms which received a high Inclusion index Ii (ratio of a term's frequency of appearance within x words of the theme word to the term's frequency of appearance in the total database) from the multi-word proximity analysis. For example, assume SATELLITE is the theme word of a proximity analysis cluster, and SENSOR is a member within the cluster. Assume SATELLITE occurs 100 times in the abstract database, and SENSOR occurs 100 times in the abstract database. Consider two cases.

In the first case, SENSOR occurs 100 times in the domain within fifty words of SATELLITE. Its Inclusion index would be one, and every time SENSOR appears in the abstract of the space-related papers obtained so far, it appears within fifty words of SATELLITE. It therefore would be recommended that SENSOR AND SATELLITE be included in a Boolean search of the abstract where the spacing could be controlled.

In the second case, SENSOR occurs zero times in the domain within fifty words of SATELLITE. Its Inclusion index would be zero, and every time SENSOR appears in the abstract of the space-related papers obtained so far, it never appears within fifty words of SATELLITE. It therefore would be recommended that SENSOR AND SATELLITE not be included in a Boolean search of the abstract where the spacing could be controlled, since there is no evidence that space-related papers would be obtained by the query.

For the Space-related literature search, most of the Boolean searches in the abstract field involved the combination of three terms. Two of the terms would typically have high values of the Inclusion index Ii, would typically not be space-unique even in combination (e.g., RADIOMETER AND SEA SURFACE TEMPERATURE), and would be constrained to occur in the same sentence. A third term, one of the multiple-definition space terms (e.g., SATELLITE, SPACE, EARTH ORBIT), was required to occur somewhere in the abstract, but not necessarily the same sentence as the other two words (e.g., SATELLITE AND (RADIOMETER SAME SEA SURFACE TEMPERATURE), where SAME is the SCI operator which constrains the two terms to the same sentence in the abstract.). Experiments were run, and it was discovered that this approach captured all the space-related papers and eliminated all the non-space related papers.

5e) Steps 5a) to 5d) reflect use of phrase frequency and proximity results to add new search terms to the query. However, these results were also used in the same manner to identify phrases which reflected non-space oriented papers. These phrases (e.g., SATELLITE TOBACCO, SATELLITE RNA*) were inserted into the query in various combinations in conjunction with the Boolean NOT operator, and their parent documents were removed from the database.

The iterative process described above was repeated until convergence was obtained. In particular, the relationship between the number of iterations and the cumulative number of space-related papers was tracked, and convergence was defined to occur when the slope of this curve became small (addition of a new iteration resulted in very few new papers).

D) Additional Querying Capabilities not Utilized

Before presenting results and conclusions, some discussion is provided about capabilities of Database Tomography which were not utilized in the present study, and other capabilities that were not used as well.

1) Database Tomography was applied only to the database of space-related articles. It was not applied to the total SCI or Engineering Compendex database for a number of logistic reasons. Application of Database Tomography to the total SCI abstracts, for

example, could help increase the probability of selecting space-related papers from an abstract search, even without the capability to control the spacing between the terms.

Consider the following case. SATELLITE occurs 1000 times in the total abstract database. SENSOR occurs 1000 times in the total abstract database. Perform a proximity analysis about the theme SATELLITE, parametrically varying the spacing of the domain. If the Inclusion index Ii of SENSOR is very high for the highest domain value (say within 100 words of SATELLITE), and if the Inclusion index Ii value remains essentially constant as the domain size decreases, then it could be concluded that whenever SENSOR occurs in the abstract, it tends to occur close to SATELLITE. This means the two terms are probably related contextually, and the query SATELLITE AND SENSOR applied to the abstract would have a high probability of identifying space-related papers. In the case where the capability to control the spacing of search terms exists, then the parametric variation described above could be used to specify the spacing desired for maximum signal-to-noise.

2) Not all fields in the SCI or Engineering Compendex were used in the iterative procedure. For example, there is an SCI field titled Related Records. It refers to other journal articles which share some of the references in the subject article. This field could have been used to expand the search in the iterative procedure through the co-citation relationships. The authors believe, however, that the co-citation relationships are not as direct as the co-word relationships because intellectual linkages are only one of many reasons for citing references (Kostoff, 1997a; MacRoberts, 1996).

3) More complex search terms were not used. For example, the search tree approach, where terms are weighted by perceived importance and then summed to provide a figure of merit, was not used. It might have some real value in the last iteration (when the terms identified by the database language have been obtained) for focusing the database output.

4) The above unused capabilities, and many more, are compatible with Simulated Nucleation, and could be employed if desired. For example, if an analyst feels that the co-citation iterative approach would provide value to the search over and above the co-word approach, then it need merely to be incorporated into the search process with no disruptive effects.

RESULTS AND CONCLUSIONS

In the initial SCI extracted database, there were 657 records, of which about 15% were judged by detailed reading of the records' abstracts to be not related to the topic of interest. Word frequency and word proximity analyses were performed on this initial database, and the results were used to both expand and refine the search query. The main focus was on expanding the search query using double and triple word phrases. This first iterative step resulted in a much larger extracted database of 1476 records, of which about 10.5 percent were judged to be non-related

to the topic.

For the next iterative step, more emphasis was placed on expanding the search query using non-contiguous words which co-occurred in the same sentence, as well as removing non-applicable records. There were relatively few new word pairs or triplets to add to the query, since the high and mid-frequency word combinations remained unchanged. This broader expansion of the search query using non-contiguous words added relatively more non-related records than the contiguous word expansion of the previous iteration, which was balanced by the removal of non-applicable records using the word frequency and proximity results. This second iterative step resulted in a moderately larger extracted database of 1726 records, of which about ten percent were judged non-applicable.

The final iterative step focused on removing the non-applicable records by adding much lower frequency terms from the phrase frequency and proximity results to the search query, since the word frequency and proximity analyses did not yield any new high or even moderate frequency contiguous or non-contiguous word combinations. This final step resulted in 1642 records, of which about 5.5 percent were judged to be non-applicable. Figure 4 shows the trend of non-applicable record percentages with number of iterations, and Figure 5 shows the trend of applicable records with number of iterations. These figures provide graphical evidence that an efficiently tailored database has been obtained.

Adding terms to the search query to expand the number of valid records is a straightforward process, whereas adding terms to the search query to remove unwanted records proved to be less efficient. The approach used to initialize the database, retrieving all records with SATELLITE* in the title, then subtracting those records with obviously non-relevant contiguous word combinations in the title (SATELLITE CLINICS, SATELLITE DNA), introduced a substantial number of non-applicable records in the extracted database. To finally remove a reasonable fraction of the non-applicable records, it was necessary to examine the moderate to low frequency terms from the word frequency and proximity results, and add these terms to the query. There proved to be a practical limitation to this process. In the proximity or frequency outputs, typically more than half of the phrases have frequencies of three or less, and three is typically used as an output cutoff to keep the outputs manageable. Many of the non-applicable records tend to have very low frequency patterns, and therefore could not be identified from the frequency analyses in an efficient manner.

Adding non-contiguous terms to the query resulted in both more applicable papers than would have been obtained with contiguous terms and more non-applicable papers as well. The removal of non-applicable papers encountered the same inherent difficulties as described in the previous paragraph. The major sources of non-applicable papers from the non-contiguous terms were from words like SPACE, which had many meanings (e.g., TIME and SPACE, HALF-SPACE, SPACE SYMMETRY) when not employed as part of a word pair or triplet in addition to the topic of interest. Adding contiguous

terms to the query resulted in the least addition of non-applicable records. The first approach to initializing the database of extracted records demonstrated the efficiency of contiguous term addition, where only a very few percent of 400 records were non-applicable.

The three iterative steps required for the present search process is typical of past experience with DT for information retrieval. For detailed research-oriented databases such as the SCI, which have very unique vocabularies and multiple meanings for the same word (as in the case of SATELLITE in this paper), perhaps another iterative step may be required. For technology-oriented databases such as the EC, which tend to have less vocabulary diversity and less esoteric vocabulary, less iterative steps are necessary. In the present study, for example, the word SATELLITE in the EC had the commonly used meaning of a man-made object orbiting the earth, and essentially every record retrieved was applicable to the topic of interest. For less technical databases (such as programmatic narrative databases), which have more generic vocabularies, sometimes two iterative steps may be all that are necessary. More iterative steps would be necessary if the analyst wishes to either add or remove records reflective of low frequency phrase occurrences. Thus, for the mid to high frequency themes of prime interest, the iteration process converges quite rapidly, but because of the continuing growth feature of Simulated Nucleation, there will always be a few records added with corresponding addition of low frequency phrase terms as well.

In summary, DT is a powerful tool for retrieving records from familiar or unfamiliar databases with a high degree of accuracy, and is sufficiently flexible to be combined with other information retrieval techniques such as search tree or co-citation approaches.

IX. BIBLIOGRAPHY

Aaker, D.A. and Tyebjee, T.T., "A Model for the Selection of Interdependent R&D Projects", IEEE Transactions on Engineering Management, Vol. EM-25, No. 2, May 1978.

Abrams P A (1991) The predictive ability of peer review of grant proposals: The case of ecology and the US National Science Foundation. Social Studies of Science **21**, 111-132.

AFOSR, "Recent Research Accomplishments of the Air Force Office of Scientific Research", AFOSR, 1989.

Alassaf-AF, "Health-Care Outcomes Management and Quality Improvement", JOURNAL OF THE ROYAL SOCIETY OF HEALTH, 1996, Vol 116, Iss 4, pp 245-252

Altura, B. T. (1990). Is Anonymous Peer Review the Best Way to Review and Accept Manuscripts? Magnesium and Trace Elements, 9 (3), 117-118

Amsler, B., "Research Towards the Development of a Lexical Knowledge Base for Natural Language Processing," Proceedings of the 1989 SIGIR Conference, Association for Computing Machinery, Cambridge, MA 1989.

Armstrong J S (1982) Barriers to scientific contributions: The author's formula. The Behavioral and Brain Sciences **5**, 197-199.

Armstrong, J.S., "Why Conduct Journal Peer Review: Quality Control, Fairness, or Innovation", Science and Engineering Ethics, 3:1, 1997.

Asher, D.I., "A Linear Programming Model for the Allocation of R&D Efforts", IRE Transactions on Engineering Management, Vol. EM-9, pp. 154-157, December 1962.

ASTEC. 1991 Funding the fabric - should Commonwealth government competitive research granting schemes contribute more to research infrastructure costs? Canberra: Australian Government Publishing Service.

Atkinson, A.C. and Bobos, A.H., "A Mathematical Basis for the Selection of Research Projects", IEEE Transactions on Engineering Management, Vol. EM-16, pp. 2-8, February 1969.

Attar, R. and Fraenkel, A.S., "Local Feedback in Full-Text Retrieval Systems", Journal of the ACM, 24:3, 1977.

Australia, "Research Performance Indicators Survey", National Board of Employment, Education and Training, Commissioned Report No. 21, Australian Government Publishing Service, Canberra, Australia, January 1993.

Averch, H., "Economic Approaches to the Evaluation of Research", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Averch, H., "Exploring the Cost-Efficiency of Basic Research Funding in Chemistry", Research Policy, Vol. 18, 1989.

Averch, H., "Measuring the Cost-Efficiency of Basic Research Investment: Input-Output Approaches", Journal of Policy Analysis and Management, Vol. 6, No. 3, 1987.

Averch, H., "Policy Uses of 'Evaluation of Research' Literature", OTA Contractor Report, July 1990.

Averch, H., "The Practice of Research Evaluation in the United

States,", Research Evaluation, Vol. 1, No. 2, 1991.

Bahl, L., Jelinek, F., and Mercer, R., "A Maximum Likelihood Approach to Continuous Speech Recognition," IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol 5, No. 2, March 1983.

Bailar, J. C. (1991). Reliability, Fairness, Objectivity and Other Inappropriate Goals in Peer Review. Behavioral and Brain Sciences, 14 (1), 137-138

Baker, L.T., "Planning an Independent Research and Development Program", in Proceedings IEEE Aerospace Electronics Conference, Dayton, Ohio, pp. 507-512, May 1969.

Baker, N.R., "R & D project selection models: an assessment," R & D Management, vol.5, Special. Issue., p.105-11, 1974

Baker, N.R., "R&D Project Selection Models: An Assessment", IEEE Transactions on Engineering Management, Vol. EM-21, No. 4, November 1974.

Baker, N.R. and Freeland, J., "Recent Advances in R&D Benefit Measurement and Project Selection Methods", Management Science, Vol. 21, No. 10, pp. 1164-1175, June 1975.

Baker, N.R. and Pound, W.H., "R&D Project Selection: Where we Stand", IEEE Transactions on Engineering Management, pp. 124-134, December 1964.

Barker, D., Smith, D., "Technology Foresight Using Roadmaps," Long Range Planning, vol 28. no. 2., 1995, pp.21-29.

Barker, K., "The 'British Model' - Evaluation by Professionals", in: Laredo, P., and Mustar, P. (eds), "EC Handbook on Evaluation", 1992.

Barker, K., Georghiou, L., and Cameron, H., "Protocol for the Evaluation of HSE Research", PREST Report, Manchester, UK, October 1988.

Battelle, "Interactions of Science and Technology in the Innovative Process: Some Case Studies", Final Report, Prepared for the National Science Foundation, Contract NSF-C 667, Battelle Columbus Laboratories, March 19, 1973.

Bauin, S., "Aquaculture: A Field by Bureaucratic Fiat,"in: Callon, M., Law, J., and Rip, A., (eds.) "Mapping the Dynamics of Science and Technology", Macmillan Press Ltd., London, 1986.

Bauin, S., Courtial, J.P., Law, J., and Whittaker, J., "Policy and the Mapping of Scientific Change: A Co-word Analysis of Research into Environmental Acidification," Scientometrics, Vol. 14, No. 3, 1988.

Beged-Dov, A.G., "Optimal Assignment of Research and Development Projects in a Large Company Using an Integer Programming Model", IEEE Transactions on Engineering Management, Vol. EM-12, December 1965.

Bell, D.C., et al, "Application of a Research Project Selection Method in the Northern Region Scientific Services Department", Central Electricity Generating Board, U.K., Report RD/H/R2, 1967.

Benson, M., Benson, E., and Ilson, R., "The BBI Combinatory Dictionary of English: A Guide to Word Combinations," John Benjamins, Amsterdam and Philadelphia, 1986.

Berezin-AA, "Peer-Review and Anonymity", SCIENTIST, 1994, Vol 8, Iss 19, pp 13-13

Blank R M (1991) The effects of double-blind versus single-blind

reviewing: Experimental evidence from the American Economic Review. American Economic Review **81**, 1041-1067. EXR

Blau, J.R., "Sociometric Structure of a Scientific Discipline," in: Jones, R.A. (ed.) Research in the Sociology of Knowledge, Sciences, and Art: An Annual Compilation of Research I, JAI Press, Greenwich, CT, 1978.

Bornstein, R. F., "Manuscript Review in Psychology: Psychometrics, Demand Characteristics, and an Alternative Model," Journal of Mind and Behaviour, 12, 1991b.

Bornstein, R. F., "The Predictive Validity of Peer Review: A Neglected Issue," Behavioral and Brain Sciences, 14:1, 1991a.

Braam, R., Moed, H., and Van Raan, A., "Mapping of Science by Combined Co-Citation and Word Analysis. 1. Structural Aspects," Journal of the American Society for Information Science, 42 (4), 1991a; "Mapping of Science by Combined Co-Citation and Word Analysis. 2. Dynamical Aspects," Journal of the American Society for Information Science, 42 (4), 1991b.

Braun, T. & Nagy, J. I. (1982). A Comparative Evaluation of some Hungarian and other National Biology, Chemistry, Mathematics and Physics Journals. Scientometrics, 4 (6), 439-455

Braun, T., and Schubert, A., "Scientometric versus Socio-Economic Indicators: Scatter Plots for 51 Countries: 1978-1980," Scientometrics, 13:1-2, 1987.

Braun, T., and Schubert, A., "The Landscape of National Performances in the Sciences, 1981-1985," Scientometrics, 20:1, 1991.

Braun, T., et al, "Scientometric Indicators Datafiles," Scientometrics, 28:2, 1993.

Braun, T., et al, "Publication Productivity: from Frequency Distributions to Scientometric indicators," Journal of Information Science, 16, 1990.

Braun, T., Glanzel, W., and Schubert, A., "An Alternative Quantitative Approach to the Assessment of National Performance in Basic Research", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, John Wiley and Sons, Chichester, UK, 1989.

Brown, E. A., "Conforming the Government R&D Function With the Requirements of the Government Performance and Results Act", Scientometrics, 36:3, 1996.

Brown, E. A., Private Communication, July 1997.

Brown, G. E., "Report of the Task Force on the Health of Research," Chairman's Report to the Committee on Science, Space, and Technology, U.S. House of Representatives, No. 56-819, U.S. Government Printing Office, Washington, 1992.

Brown, G. E. 1993 Science's real role in policy making. Chemical & Engineering News. 71, 9-11.Buechner, Q. 1974 Proposal costs. Journal of the Society of Research Administrators. 5, 47-50.

Callan, J., Croft, W.B., and Broglio, J., "TREC and TIPSTER Experiments with INQUERY", Information Processing and Management, 1995.

Callon, M., "Pinpointing Industrial Invention: An Exploration of Quantitative Methods for the Analysis of Patents," in: Callon, M., Law, J., and Rip, A., (eds.) "Mapping the Dynamics of Science and

Technology", Macmillan Press Ltd., London, 1986.

Callon, M., Courtial, J.P., and Laville, F., "Co-word Analysis as a Tool for Describing the Network of Interactions.between Basic and Technological Research: The Case of Polymer Chemistry," Scientometrics, Vol. 22, No. 1, 1991a.

Callon, M., Courtial, J.P., Crance, P., Laredo, P., Mauguin, P., Rabeharisoa, V., Rocher, Y.A., and Vinck, D., "Tools for the Evaluation of Technological Programmes: an Account of Work Done at the Centre for the Sociology of Innovation," Technology Analysis and Strategic Management, Vol. 3, No. 1, 1991b.

Callon M., Courtial, J. P., and Turner, W. A., "PROXAN: A Visual Display Technique for Scientific and Technical Problem Networks," Second Workshop on the Measurement of R&D Output, Paris, France, December 5-6, 1979.

Callon, M., Courtial, J.P., Turner, W.A., and Bauin, S., "From Translations to Problematic Networks: An Introduction to Co-word Analysis," Social Science Information, 22, 1983.

Capron, H., "Economic Quantitative Methods for the Evaluation of the Impact of R&D Programmes: A State of the Art", Commission of the European Communities, Report EUR 14864 EN, November 1992.

Carnegie, "Enabling the Future: Linking Science and Technology to Societal Goals," Carnegie Commission on Science, Technology, and Government, Carnegie Commission, New York, NY, 1992.

Carpenter, M. P., "Assessment of the Linkages Between Patents and Fundamental Research", Presented at the OECD Patents and Innovation Statistics Seminar, Paris, France, June 1982.

Carpenter, M. P., and Narin, F., "Validation Study: Patent Citations as Indicators of Science and Foreign Dependence", World Patent Information, Vol. 5, No. 3, 1983.

Carpenter, M. P., Narin, F., and Woolf, P., "Citation Rates to Technologically Important Patents", World Patent Information, Vol. 3, No. 4, 1981.

Carpenter, M.P., Cooper, M., and Narin, F., "Linkage Between Basic Research Literature and Patents", Research Management, 13:2, March 1980.

Cawkell, A. E., "Understanding Science by Analysing its Literature", in: Garfield, E., Essays of an Information Scientist, Vol. 2, Phila, PA, ISI Press, 1977.

Ceci, S. J. & Peters, D. P. 1982 Peer review: a study of reliability.Change. 14, 44-48.

Ceci, S. J. & Peters, D. (1984). How Blind Is Blind Review? American Psychologist, 39 (2), 1491-1494

Cetron, M.J., Martino, J. and Roepcke, L., "The Selection of R&D Program Content-Survey of Quantitative Methods", IEEE Transactions on Engineering Management, Vol. EM-14, No. 1, pp. 4-13, March 1967.

Chomsky, N., "Aspect of the Theory of Syntax," MIT Press, New York, NY, 1965.

Choueka, Y., "Looking for Needles in a Haystack or Locating Interesting Collocational Expressions in Large Textual Databases," Proceedings of the RIAO Conference on User-Oriented Content-Based Text and Image Handling, Cambridge, MA, March 21-24, 1988.

Choueka, Y., Klein, T., and Neuwitz, E., "Automation Retrieval

of Frequent Idiomatic and Collocational Expressions in a Large Corpus," ALLC Journal, Vol. 4, 1983.

Chubin, D. E. and Hackett, E. J., "Peerless Science: Peer Review and U. S. Science Policy", State University of New York Press, Albany, NY, 1990.

Chubin, D. E., "Research Evaluation and the Generation of Big Science Policy", Knowledge: Creation, Diffusion, Utilization, Vol. 9, No. 2, December 1987b.

Chubin, D. E., "Grants Peer Review in Theory and Practice", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Chubin, D. E., and Jasanoff, S., (Eds.), Special Issue on Peer Review, Science, Technology, and Human Values, 10:3, Summer 1985.

Chubin, D. E., "Designing Research Program Evaluations: A Science Studies Approach", Science and Public Policy, Vol. 14, No. 2, April 1987a.

Church, K., and Gale, W., "Poor Estimates of Context are Worse Than None," ARPA Speech and Natural Language Workshop, Hidden Valley, PA, June 1990.

Church, K., and Hanks, K., "Word Association Norms, Mutual Information, and Lexicography," Proceedings of the 27th Meeting of the Association of Computational Linguistics, Vancouver, BC, 1989.

Cicchetti, D. V., "The Reliability of Peer Review for Manuscript and Grant Submissions: A Cross-Disciplinary Investigation," Behavioral and Brain Sciences, 14:1, 1991.

Cicchetti, D. V. (1976). Assessing Inter-Rater Reliability for Rating Scales: Resolving some Basic Issues. British Journal of Psychiatry, 129, 452-456

Cicchetti, D. V. & Eron, L. D. (1979). The Reliability of Manuscript Reviewing for the Journal of Abnormal Psychology. Proceedings of the American Statistical Association (Social Statistics Section), 22, 596-600

Clayson-DB, "Anonymity in Peer-Review - Time for a Change - Comment", REGULATORY TOXICOLOGY AND PHARMACOLOGY, 1995, Vol 22, Iss 1, pp 101-101

Cochran, M.A., et al, "Investment Model for R&D Project Evaluation and Selection", IEEE Transactions on Engineering Management, Vol. EM-18, August 1971.

Cole, J., and Cole, S., "Peer Review in the National Science Foundation: phase two of a study," National Research Council, 1981a, NTIS Acc. No. PB82-182130.

Cole-S, "Consensus and the Reliability of Peer-Review Evaluations", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 140-140

Cole, S., Cole, J. and Simon, G., "Chance and Consensus in Peer Review," Science, Vol. 214, November 1981b.

Cole, S., Rubin, L., and Cole, J., "Peer Review in the National Science Foundation: phase one of a study,", National Research Council, 1978, NTIS Acc. No. PB83-192161.

Collins, P., and Wyatt, S., "Citations in Patents to the Basic Research Literature", Research Policy, 17, 1988.

Colman-AM, "Unreliable Peer-Review - Causes and Cures of Human

Misery", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 141-141

Cook, W.D. and Seifford, L.M., "R&D Project Selection in a Multi-dimensional Environment: A Practical Approach", Journal of the Operations Research Society, Vol. 33, pp. 397-405, 1982.

Cooley, S., Hehmeyer, J., and Sweeney, P., "Modeling R&D Resource Allocation," Research Management, Jan-Feb 1986, pp. 40-45.

Cooper, M.J., "An Evaluation System for Project Selection", Research Management, Vol. 21, pp. 29-33, 1978.

Cooper, R.G., "An Emperically Derived New Product Project Selection Model", IEEE Transactions on Engineering Management, Vol. EM-28, No. 3, August 1981.

Courtial, J. P., "Technical Issues and Developments in Methodology," in: Callon, M., Law, J., and Rip, A., (eds), Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World, the MacMillan Press Ltd, London, England, 1986.

Courtial, J.P., "A Mathematical Model of Development in a Research Field," Scientometrics, Vol.19, No.1, 1990b.

Courtial, J.P., and Law, J., "A Co-word Study of Artificial Intelligence," Social Studies of Science, Vol. 19, 1989.

Courtial, J.P., Turner, W.A., and Michelet, B., "Scientific and Technological Information Banks for Research Networks Management Purposes," Research Policy, Vol.19, 1990a.

Cox-D Gleser-L Perlman-M Reid-N Roeder-K, "Report of the AD-Hoc-Committee-on-Double-Blind-Refereeing", STATISTICAL SCIENCE, 1993, Vol 8, Iss 3, pp 310-317

Cozzens, S. E., "Expert Review in Evaluating Programs", Science and Public Policy, 14:2, April 1987.

Cram-DL Stebbins-M Eom-HS Ratto-N Sugiyama-D, "Peer-Review as a Quality Assurance Mechanism in 3 Pharmacist-Run Medication-Refill Clinics", AMERICAN JOURNAL OF HOSPITAL PHARMACY, 1992, Vol 49, Iss 11, pp 2727-2730

Cramer, R.H. and Smith, B.E., "Decision Models for the Selection of Research Projects", Eng. Economist, Vol. 9, No. 2, pp. 1-20, January - February 1964.

Croft, W., and Harper, D., "Using Probabilistic Models of Document Retrieval Without Relevance Information", Journal of Documentation, 35, 1979.

Crothers-C, "Peer-Review Reliability - The Hierarchy of the Sciences", BEHAVIORAL AND BRAIN SCIENCES, 1993, Vol 16, Iss 2, pp 398-399

Daniel-HD, "An Evaluation of the Peer-Review Process at Angewandte-Chemie", ANGEWANDTE CHEMIE-INTERNATIONAL EDITION IN ENGLISH, 1993, Vol 32, Iss 2, pp 234-238

Datz, I.M., "Organizing an R&D Oriented Computer Activity-Management and Control of an Independent Research and Development Program", Angew. Informatik, pp. 209-218, May 1974.

De Saussure, F., "Cours de Linguistique Generale," 4eme Edition, Librairie Payot, Paris, 1949.

Dean, B.V., "A Research Laboratory Performance Model," Quantitative Decision Aiding Techniques for Research and Development, M. J. Cetron, H. Davidson, and A. H. Rubenstein, eds., Gordon and

Breach, 1972.

Dean, B.V. and Nishry, M., "Scoring and Profitability Models for Evaluating and Selecting Engineering Projects", Operations Research, Vol. 13, No. 4, pp. 550-569, 1965.

Dean, B.V. and Sengupta, S.S., "Research Budgeting and Project Selection", IRE Transactions on Engineering Management, 1962.

Debakey-L, "Journal Peer Reviewing - Anonymity or Disclosure", ARCHIVES OF OPHTHALMOLOGY, 1990, Vol 108, Iss 3, pp 345-349

Delcomyn-F, "Peer-Review - Explicit Criteria and Training Can Help", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 144-144

DOD, "The Department of Defense Report on the Merit Review Process for Competitive Selection of University Research Projects and an Analysis of the Potential for Expanding the Geographic Distribution of Research," April 1987, DTIC Acc. No. 88419044.

DOD, Project Hindsight, Office of the Director of Defense Research and Engineering, Wash., D. C., DTIC No. AD495905, Oct. 1969.

DOE, "An Assessment of the Basic Energy Sciences Program", Office of Energy Research, Office of Program Analysis, Report No. DOE/ER-0123, March 1982.

DOE, "Health and Environmental Research: Summary of Accomplishments", Office of Energy Research, Office of Program Analysis, Report No. DOE/ER-0194, May 1983

DOE, "Health and Environmental Research: Summary of Accomplishments", Office of Energy Research, Office of Program Analysis, Report No. DOE/ER-0275, August 1986.

DOE, "Multiprogram Laboratory Appraisals", DOE ORDER 5000.2A, September 1988.

DOE, "Procedures for Peer Review Assessments", Office of Energy Research, Office of Program Analysis, Report No. DOE/ER-0491P, April 1991.

DOE, "Procedures for Peer Review Assessments", Office of Energy Research, Office of Program Analysis, Report No. DOE/ST-0007P, Revised January 1993.

DOE, "The Ultimate Structure of Matter: The High Energy Physics Program from the 1950s through the 1980s", Office of Energy Research, Report No. DOE/ER-0435, February 1990.

DOE, Evaluation of Alternate Magnetic Fusion Concepts 1977", DOE/ET-0047, U.S. Department of Energy, Assistant Secretary for Energy Technology, Office of Fusion Energy, May 1978.

DOE, Telcon with Office of Program Analysis staff, 2/26/1993b.

Dubnicki, C. and Williams, J.B., 1991. Getting Peak Performance in the Knowledge-Based Organization: The Shape of Things to Come, Part 5. Healthcare Forum Journal, Jan/Feb, pp. 33-36.

Edwards, W., 1980. Multiattribute Utility for Evaluation: Structures, Uses, and Problems, in M. Klein and K. Teilmann (eds.) Handbook of Criminal Justice Evaluation. Beverly Hills, CA: Sage Publications.

Edwards, W., Newman, J.R., Snapper, K., and Seaver, D., 1982. Multiattribute Evaluation. Beverly Hills, CA: Sage Publications.

Ehlen-CR Welker-RB, "Procedural Fairness in the Peer and Quality Review Programs", AUDITING-A JOURNAL OF PRACTICE & THEORY,

1996, Vol 15, Iss 1, pp 38-52

Ellis, L.W., "The Financial Side of Industrial Research Management", New York, Wiley, 1984.

Engelsman, E. C. and Van Raan, A. F. J., "Mapping of Technology: A First Exploration of Knowledge Diffusion amongst Fields of Technology," Research Report to the Ministry of Economic Affairs, CWTS-91-02, Centre for Science and Technology Studies, Leiden, March 1991.

Englert, R.D., 1991. Strategic R & D Planning. Eng. Management Review, Summer 91, pp. 42-53.

Ernst-E, "Criticizing the Critics - Is Peer-Reviewing Fair", JOURNAL OF CLINICAL EPIDEMIOLOGY, 1994, Vol 47, Iss 7, pp 817-818

Evans-AT Mcnutt-RA Fletcher-RH Fletcher-SW, "The Effects of Blinding on the Quality of Peer-Review - A Randomized Trial", CLINICAL RESEARCH, 1990, Vol 38, Iss 2, pp A738-A738

Fahrni, P., Spatig, M., "An Application-Oriented Guide to R&D Project Selection and Evaluation Methods," R&D Management, vol 20. no. 2, 1990, pp.155-171.

Fielder-JH, "Disposable Doctors - Incentives to Abuse Physician Peer-Review", JOURNAL OF CLINICAL ETHICS, 1995, Vol 6, Iss 4, pp 327-332

Firth, J., "A Synopsis of Linguistic Theory 1930-1955", in Studies in Linguistic Analysis, Philological Society, Oxford; Reprinted in Palmer, F. (ed), Selected Papers of J. R. Firth, Longman, Harlow, 1968.

Fisher-M Friedman-SB Strauss-B, "The Effects of Blinding on Acceptance of Research Papers by Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1994, Vol 272, Iss 2, pp 143-146

Fletcher R H & Fletcher S W (1997) Evidence for the effectiveness of peer review. Science and Engineering Ethics 3:1 1997.

Forsdyke, D. R., "Bicameral Grant Review: An Alternative to Conventional Peer Review", FASEB Journal, 5, 1991.

Foruria, C., and Souder, W., "The Evolution and Transfer of National Technologies: A Conceptual Model with Comparative Case Studies," Journal of Scientific & Industrial Research, vol. 54, April 1995, pp.231-242.

Fox-MF, "Scientific Misconduct and Editorial and Peer-Review Processes", JOURNAL OF HIGHER EDUCATION, 1994, Vol 65, Iss 3, pp 298-309

Frame, J. D., "Quantitative Indicators for Evaluation of Basic Research Programs/ Projects", IEEE Transactions on Engineering Management, Vol. EM-30, No. 3, August 1983.

Franklin, J. J. and Johnston, R., "Co-citation Bibliometric Modeling as a Tool for S&T Policy and R&D Management: Issues, Applications, and Developments," in Van Raan, A.F.J. (ed.), Handbook of Quantitative Studies of Science and Technology, North Holland, 1988.

Frazier, S. P., "University Funding: Information on the Role of Peer Review at NSF and NIH", U.S. General Accounting Office Report No. GAO/RCED-87-87FS, March 1987.

Friedman-DP, "Manuscript Peer-Review at the Ajr - Facts,

Figures, and Quality Assessment", AMERICAN JOURNAL OF ROENTGENOLOGY, 1995, Vol 164, Iss 4, pp 1007-1009

Gabel-RA, "Quality Assurance Peer-Review for Recredentialing Relicensure in New-York-State", INTERNATIONAL ANESTHESIOLOGY CLINICS, 1992, Vol 30, Iss 2, pp 93-101

Garfield, E., Malin, M.V., and Small, H., "Citation Data as Science Indicators," in: Elkana, Y., Lederberg, J., Merton, R.K., Thackray, A., and Zuckerman, H., (eds), Toward a Metric of Science: The Advent of Science Indicators, John Wiley and Sons, New York, 1978.

Garguilo, G.R. et al., "Developing Systematic Procedures for Directing Research Programs", IEEE Transactions on Engineering Management, Vol. EM-8, pp. 24-29, March 1981.

Garson, L. R. (1980). Computer-aided Selection of Reviewers and Manuscript Control. Scholarly Publishing, October, 65-74

Gear, A.E., "A Review of Some Recent Developments in Portfolio Modeling in Applied Research and Development", IEEE Transactions on Engineering Management, Vol. EM-21, No. 4, November 1974.

Gear, A.E., Lockett, A.G. and Pearson, A.W., "Analysis of Some Portfolio Selection Models For R&D", IEEE Transactions on Engineering Management, Vol. EM-18, No. 2, May 1971.

Geisler, E., "An Integrated Cost-Performance Model of Research and Development Evaluation," OMEGA, 23:3, 1995.

Georghiou, L., Giusti, W.L., Cameron, H.M. and Gibbons, M., "The Use of Co-nomination Analysis in the Evaluation of Collaborative Research," in Van Raan, A.F.J. (ed.), Handbook of Quantitative Studies of Science and Technology, North Holland, 1988.

GERMANY,, "On Our Own Behalf - Safeguarding Quality of Medical-Journals Through Peer-Review", SCHWEIZERISCHE MEDIZINISCHE WOCHENSCHRIFT, 1988, Vol 118, Iss 8, pp 255-256

Gibbons, M., "Methods for the Evaluation of Research", International Journal of Institutional Management in Higher Education, Vol. 9, No.1, March 1985.

Gibbons, M., and Georghiou, L., "Evaluation of Research - A Selection of Current Practices," OECD, Paris 1987, ISBN 92-64-12981-2.

Gilbert-JR Williams-ES Lundberg-GD, "Is There Gender Bias in Jamas Peer-Review Process", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1994, Vol 272, Iss 2, pp 139-142

Goodman, S. N., et al, "Manuscript Quality Before and After Peer-Review and Editing at Annals of Internal Medicine", Annals of Internal Medicine, 121:1, 1994.

Goodstein-D, "Ethics and Peer-Review - Commentary", STEM CELLS, 1995, Vol 13, Iss 5, pp 574-574

Gordon, M. D., and Lindsay, R. K., "Toward Discovery Support Systems: A Replication, Re-Examination, and Extension of Swanson's Work on Literature-Based Discovery of a Connection between Raynaud's and Fish Oil," JASIS, 47:2, February 1996.

Gorman-ME, "Replication, Reliability and Peer-Review - A Case-Study", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 149-149

GPRA, Government Performance and Results Act of 1993 (PL 103-62)

Greene-R, "Is There an Alternative to Peer-Review", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 149-149

Gresty-MA, "Peer-Review and Anonymity", NEURO-OPHTHALMOLOGY, 1995, Vol 15, Iss 6, pp 281-282

Griliches, Z., "Issues in Assessing the Contribution of Research and Development to Productivity Growth", The Bell Journal of Economics, Vol. 10, Spring 1979.

Griliches, Z., "Productivity, R&D, and the Data Constraint", The American Economic Review, 84:1, March 1994.

Griliches, Z., "Productivity, R&D, and Basic Research at the Firm Level in the 1970s", NBER Working Paper No. 1547, typescript (National Bureau of Economic Affairs, Cambridge, MA), January 1985.

Griliches, Z., "Research Costs and Social Returns: Hybrid Corn and Related Innovations," Journal of Political Economy, Vol. 66, 1958.

Gupta-AP, "The Peer-Review Process, Multiple Publications, and the Overcrowded by-Line - Roles of the Editor, Reviewer, and Author", INTERNATIONAL JOURNAL OF INSECT MORPHOLOGY & EMBRYOLOGY, 1996, Vol 25, Iss 1-2, pp 19-24

Gustafson, D.H., Pai, G.K. and Kramer, G.C., " A Weighted Aggregate Approach to R&D Project Selection", AIIE Transactions, Vol. 3, No. 1, pp. 22-30, March 1971.

Hall, D., and Nauda, A., "An Interactive Approach for Selecting IR&D Projects," IEEE Transactions on Engineering Management, Vol. 37, No. 2, May 1990.

Halliday, M. A. K., "Lexis as a Linguistic Level," in: Bazell et al (eds), In Memory of J. R. Firth," Longmans Linguistic Library, London, England, 1966.

Halpin, G. (et al). 1986 Reliability of ratings of research proposals submitted for funding. In Annual Meeting of the Mid-South Education Research Association, . Memphis, TN:

Harris, Z., "Mathematical Structures of Language," New York, Wiley, 1968.

Hazelrigg, G.A., "Evaluation of Long Term RD&D Programs in the Presence of Market Uncertainties", Energy Systems Policy, Vol. 5, No. 2, 1982.

Healey, P., Rothman, H., and Hoch, P., "An Experiment in Science Mapping for Research Planning," Research Policy, Vol. 15, 1986.

Helin, A.F. and Souder, W.E., "Experimental Test of a Q-Sort Procedure for Prioritizing R&D Projects", IEEE Transactions on Engineering Management, EM-21, No. 4, November 1974.

Hellwig, H., "Transitioning Research Results: A Challenge in Communication", Proceedings: Portland International Conference on Management of Engineering and Technology, October 27-31, 1991.

Hensler, D. R., "Perceptions of the National Science Foundation Peer Review Process: A Report on a Survey of NSF Reviewers and Applicants," NSF Report No. NSF 77-33, 1976, NTIS Acc. No. PB-271775.

Hensley, O.,Gulley, B. & Eddleman, J. 1980 Evaluating development costs for a proposal to a federal agency. Journal of the Society of Research Administrators. 12, 35-39.

Heppenheimer, T. A., "What Made Bell Labs Great", Invention and Technology, Summer 1996.

Hertz, D.B., "Risk Analysis in Capital Investment", Harvard Business Review, Vol. 42, pp. 96-106, 1964.

Hespos, R.F. and Strassman, P.A., "Stochastic Decision Trees for the Analysis of Investment Decisions", Management Science, Vol. 11, No. 10, pp. 244-259, August 1965.

Hess, S.W., "A Dynamic Programming Approach to R&D Budgeting and Project Selection", IRE Transactions on Engineering Management, Vol. EM-9, pp. 170-179, December 1962.

Hicks, D., Martin, B., and Irvine, J., "Bibliometric Techniques for Monitoring Performance in Technologically Oriented Research: The Case of Integrated Optics", R&D Management, Vol. 16, No. 3, 1986.

Hirschman, D.J., "Peer Review and the Contract between Science and Society", The Environmental Professional, To be Publ., 1993.

Hornby, A.S., Gatenby, E. V., and Wakefield, H., "Idiomatic and Syntactic English Dictionary," Kaitakusha, Tokyo, Japan, 1942.

Ibrahim, S.M.A., "The Use of Matrices for the Determination of Science and Technology Priority Areas for the Achievement of Energy Goals in Egypt", Energy Research, Vol.8, 247-262, 1984.

IDA, "DARPA Technical Accomplishments", Volume I, IDA Paper P-2192, February 1990; Volume II, IDA Paper P-2429, April 1991; Volume III, IDA Paper P-2538, July 1991, Institute for Defense Analysis.

IEEE, Issue With Focus on Research Program Evaluation, IEEE Transactions on Engineering Management, Vol. EM-30, No.3, August 1983.

IEEE, Special Issue on Research Project Selection, IEEE Transactions on Engineering Management, Vol. EM-21, No.4, November 1974.

IITRI, "Technology in Retrospect and Critical Events in Science", Illinois Institute of Technology Research Institute Report, December, 1968.

Iordanskaja, L., Kittredge, R., and Polguere, A., "Lexical Selection and Paraphrase in a Meaning-text Generation Model," in: Paris, C. et al (eds), "Natural Language Generation in Artificial Intelligence and Computational Linguistics," Kluwer Academic Publishers, 1990.

Irvine, J., "Evaluation of Scientific Institutions: Lessons from a Bibliometric Study of UK Technical Universities", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, John Wiley and Sons, Chichester, UK, 1989.

Irvine, J. and Martin, B. R., "Foresight in Science: Picking the Winners," Frances Pinter, London, 1984.

Isaacs, E., and Tang, J., "Technology Transfer: So Much Research, So Few Good Products," Communications of the ACM, 39:9, 1996.

Jackson, B., "Decision methods for evaluating R&D projects," Research Management, July-August 1983, pp. 16-22.

Jing, Y. and Croft, W.B., "An Association Thesaurus for Information Retrieval", in Proceedings of RIAO 94, 1994.

Johnson-AL Johnson-DAW, "Peer-Review of Risperidone in the Treatment of Patients with Chronic-Schizophrenia - A Multi-National, Multicenter, Double-Blind, Parallel-Group Study Versus Haloperidol", BRITISH JOURNAL OF PSYCHIATRY, 1995, Vol 166, Iss JUN, pp 727-731

Johnston, R., "Project Selection Mechanisms: International Comparisons", OTA Contractor Report, July 1990.

Keefer, D.L., "Allocation Planning for R&D with Uncertainty and Multiple Objectives", IEEE Trans. on Engineering Management, Vol. EM-25, No. 1, pp. 8-14, 1978.

Kellie-SE Kelly-JT, "Medicare Peer-Review Organization Preprocedure Review Criteria - An Analysis of Criteria for 3 Procedures", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1991, Vol 265, Iss 10, pp 1265-1270

Keown, A.J., et al, "Allocation of Research and Development Funds: A Zero-one Goal Programming Approach", Omega, Vol. 7, pp. 345-351, 1979.

Keown-D, "The Journal of Buddhist Ethics - An Online Journal", LEARNED PUBLISHING, 1996, Vol 9, Iss 3, pp 141-145

Kerpelman, L. C., and Fitzsimmons, S. J., "Methods for the Strategic Evaluation of Research Programs: The State-of-the Art", and "Annotated Bibliography", NSF Contract No. PRA 8400688, Abt Associates Inc., 1985.

Kessler-HB Clair-MR, "Development and Implementation of a Peer-Review Quality Assurance Program for Obstetric Us - Financial Analysis and Results", RADIOLOGY, 1992, Vol 185, Iss S, pp 143-143

Kiesler, C. A. (1991). Confusion Between Reviewer Reliability and Wise Editorial and Funding Decisions. Behavioral and Brain Sciences, 14 (1), 151-152

King, J., "A Review of Bibliometric and Other Science Indicators and Their Role in Research Evaluation", J. Information Sci., 13, 1987

Kingsley, G., "The Use of Case Studies in R&D Impact Evaluations", in Assessing R&D Impacts: Method and Practice, Bozeman, B. and Melkers, J., Eds. (Kluwer Academic Publishers, Norwell, MA) 1993.

Kittredge, R., Polguere, A., and Goldberg, E., "Synthesizing Weather Forecasts from Formatted Data," Proceedings of the 11th COLING, Int'l Conference on Computational Linguistics, 1986.

Klahr, D. 1985 Insiders, outsiders, and efficiency in a National Science Foundation Panel. American Psychologist. 40, 148-154.

Knezo, G., Congressional Research Service, at a colloquium on "Effective Research Assessment: Criteria and Models for Success," Washington, DC, December 16, 1993, organized by Susan E. Cozzens, Rensselaer Polytechnic Institute, under NSF Grant No. SBE-9220059.

Knox, F. G. (1981). No Unanimity about Anonymity. Journal of Laboratory and Clinical Medicine, 97 (1), 1-3

Kostoff, R.N., "Status and Prospects of Advanced Fissile Fuel Breeders", Third US/USSR Symposium on Fusion-Fission Hybrids, Princeton, NJ, 1979, DOE CONF-790103.

Kostoff, R. N., "Thermal Stresses in Neutron Multipliers in Fusion Reactor Blankets", Res Mechanica Letters, 1:12, December 1981.

Kostoff, R. N., Peaslee, A. F., and Ribe, F. K., "Application of Electromagnetic Guns to Impact Fusion", IEEE Transactions on Magnetics, MAG-18:1, January 1982a.

Kostoff, R. N., and Bohachevsky, I. O., "Cyclic Temperature and Thermal Stress Fluctuations in Fusion Reactors", Nuclear Technology/

Fusion, 2:4, October 1982b.

Kostoff, R. N., "A Cost/ Benefit Analysis of Commercial Fusion-Fission Hybrid Reactor Development", Journal of Fusion Energy, 3:2, 1983a.

Kostoff, R. N., "Neutron Multiplier Thermal Stresses in Pure Fusion and Fusion-Fission Reactor Blankets", Res Mechanica, 9:1, 1983b.

Kostoff, R. N., "Temperature Prediction and Control in Pulsed Fusion-Hybrid Neutron Multipliers", Journal of Fusion Energy, 4:4, 1985.

Kostoff, R. N., "Evaluation of Proposed and Existing Accelerated Research Programs by the Office of Naval Research", IEEE Trans. of Engineering Management, 35:4, Nov. 1988.

Kostoff, R. N., Lasdon, L., and Stanford, L. B., "Some Large Scale Optimization Problems in the Office of Naval Research", ORSA Annual Meeting, Vancouver, B. C., Canada, May 8-10, 1989.

Kostoff, R. N. and Stanford, L. B., "Program Funding Profiles under Budgetary Constraints", Research Evaluation, 1:1, April 1991a.

Kostoff, R. N., "Word Frequency Analysis of Text Databases", ONR Memorandum 5000 Ser 10P4/ 1443, April 12, 1991b.

Kostoff, R. N., "A Quantitative Approach to Determining the Impact of Research", Proceedings: Twenty-Second Annual Pittsburgh Conference on Modeling and Simulation, May 2-3, 1991c.

Kostoff, R. N., "Database Tomography: Multidisciplinary Research Thrusts from Co-Word Analysis," Proceedings: Portland International Conference on Management of Engineering and Technology, October 27-31, 1991d.

Kostoff, R. N., "Research Impact Assessment", Proceedings: National Research Council Workshop on Research Project Measurement and Management Decision Making, Wash., DC, December 11-12, 1991e.

Kostoff, R. N., "Research Impact Assessment," Proceedings: Third International Conference on Management of Technology, Miami, FL, February 17-21, 1992a. Larger text available from author.

Kostoff, R. N., "Research Impact Assessment", Presented to Colloquia at Sandia National Labs, Naval Weapons Center, Naval Coastal Systems Station, March-April, 1992b.

Kostoff, R. N., Unpublished Results, 1992c.

Kostoff, R. N., "Federal Research Impact Assessment Methods", Research Management Review, 6:2, Fall 1992, 1992d.

Kostoff, R. N., "Research Impact Assessment: A Summary", Business Economics, Volume 28, January 1993a.

Kostoff, R. N., "Evaluating Federal R&D in the U. S.," in Assessing R&D Impacts: Method and Practice, Bozeman, B. and Melkers, J., Eds. (Kluwer Academic Publishers, Norwell, MA) 1993b.

Kostoff, R. N., "Co-Word Analysis," in Assessing R&D Impacts: Method and Practice, Bozeman, B. and Melkers, J., Eds. (Kluwer Academic Publishers, Norwell, MA) 1993c.

Kostoff, R. N., "Semi-Quantitative Methods for Research Impact Assessment", Technological Forecasting and Social Change, 44:3, November, 1993d.

Kostoff, R. N., "Database Tomography for Technical Intelligence", Proceedings: Eighth Annual Conference of the Society

for Competitive Intelligence Professionals, Los Angeles, CA 1993e.

Kostoff, R. N., "Database Tomography for Technical Intelligence," Competitive Intelligence Review, 4:1, Spring 1993f.

Kostoff, R.N. and Eberhart, H.J., "Database Tomography: Applications to Technical Intelligence," Proceedings: Technology 2003, Vol. 2, Anaheim, CA, Dec. 7-9, 1993g.

Kostoff, R. N., Averch, H., and Chubin, D., "Research Impact Assessment: Introduction and Overview", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994a.

Kostoff, R. N., "Research Impact Assessment: Federal Peer Review Practices", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994b.

Kostoff, R. N., "Research Impact Assessment: Semi-Quantitative Methods", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994c.

Kostoff, R. N., "Semi-Quantitative/Quantitative Research Impact Assessment Methods", Science and Public Policy, 21:1, February 1994d.

Kostoff, R. N., "Quantitative/Qualitative Federal Research Impact Evaluation Practices", Technological Forecasting and Social Change, 45:2, February 1994e.

Kostoff, R.N., "Research Impact Assessment: Problems, Progress, Promise," Proceedings: Fourth International Conference on Management of Technology, Miami FL, 1994f.

Kostoff, R. N., "Successful Innovations: Lessons From Retrospective Studies", Research-Technology Management, 37:2, March-April 1994g.

Kostoff, R.N., "Database Tomography: Origins and Applications," Competitive Intelligence Review, Special Issue on Technology, 5:1, Spring 1994h.

Kostoff, R. N., "Research Impact Quantification," R&D Management, 24:3, July 1994i.

Kostoff, R. N., "Federal Research Impact Assessment: State-of-the-Art", Journal of the American Society for Information Science, 45:6, July 1994j.

Kostoff, R. N. and Eberhart, H. J., "Database Tomography: Applications to Information, Logistics, and Personnel Management", Proceedings: Advanced Information Systems & Technology for Acquisition, Logistics, & Personnel Applications, Williamsburg, VA, March 28-30, 1994k.

Kostoff, R. N., "Research Impact Assessment: Principles and Applications to Proposed, Ongoing, and Completed Projects", Journal of Investigative Radiology, 29:9, September 1994l.

Kostoff, R. N., "The Handbook of Research Impact Assessment", Fifth Edition, Summer 1995, DTIC Report Number ADA 296021, 1995a.

Kostoff, R. N., "Database Utilization for Research Assessment," The Journal of Information Technology Management, VI:2, 1995b.

Kostoff, R.N., "Research Requirements for Research Impact Assessment," Research Policy, 24, 1995c.

Kostoff, R. N., "Federal Research Impact Assessment: Axioms, Approaches, Applications," Scientometrics, 34:2, 1995d.

Kostoff, R. N., Eberhart, H. J., and Miles, D., "System and

Method for Database Tomography", U. S. Patent Number 5440481, August 8, 1995e.

Kostoff, R. N., "Research Performance Effectiveness and Impact," Chapter 31, in Gaynor, G. H. (ed.), Handbook of Technology Management, McGraw-Hill, Inc., 1996a.

Kostoff, R. N., "The Principles and Practices of Federal Research Impact Assessment," Encyclopedia of Library and Information Science, 58, Marcel Dekker, 1996b.

Kostoff, R. N., "Performance Measures for Government-Sponsored Research: Overview and Background", in: Kostoff, R. N., (ed.), Scientometrics, Special Issue on Performance Measures for Government-Sponsored Research, 36:3, July-August 1996c.

Kostoff, R. N., "The Principles and Practices of Peer Review", in: Stamps, A. E., (ed.), Science and Engineering Ethics, Special Issue on Peer Review, 3:1, 1997a.

Kostoff, R. N., "Use and Misuse of Metrics in Research Evaluation", Science and Engineering Ethics, 3:2, 1997b.

Kostoff, R. N., "Database Tomography for Technical Intelligence: Analysis of the Research Impact Assessment Literature", Competitive Intelligence Review, 8:2, Summer 1997c.

Kostoff, R. N., "Database Tomography for Technical Intelligence: Comparative Analysis of the Research Impact Assessment Literature and the Journal of the American Chemical Society:, Scientometrics, 40:1, 1997d.

Kostoff, R. N., "Database Tomography for Technical Intelligence: A Roadmap of the Near-Earth Space Science and Technology Literature", Information Processing and Management, to be Published, 1997e.

Kostoff, R. N., "Database Tomography for Information Retrieval", Journal of Information Science, 23:4, 1997f.

Kostoff, R. N., "Identification of Research Program Risk", Research-Technology Management, 40:3, May-June 1997g.

Kostoff, R. N., "Peer Review: The Appropriate GPRA Metric for Research", Science, Volume 277, 1 August 1997h.

Kostoff, R. N., "Research Program Peer Review: Principles and Practices", http://www.dtic.mil/dtic/kostoff/index.html, 1997i.

Kostoff, R. N., "Accelerating the Conversion of Science to Technology: Introduction and Overview", Journal of Technology Transfer, 22:3, Fall 1997j.

Kostoff, R. N., Letter to the Editor, The Scientist, February 3, 1997k.

Kostoff, R. N., Letter to the Editor, Physics Today, March 1997l.

Kostoff, R. N., "Citation Analysis Cross-Field Normalization: A New Paradigm", Scientometrics, 39:3, 1997m.

Kostoff, R. N., "Identification of Medical Research Directions Through Literature Analysis", Science, submitted for Publication, 1997n.

Kostoff, R. N., "Database Tomography for Technical Intelligence: Analysis of the Hypersonic and Supersonic Flow Literature", to be Submitted for Publication, 1997o.

Kostoff, R. N., "Science and Technology Roadmaps", http://www.dtic.mil/dtic/kostoff/index.html, 1997p.

Kostoff, R. N., The Handbook of Research Impact Assessment," Seventh Edition, Summer 1997, DTIC Report Number ADA296021. Also, available at http://www.dtic.mil/dtic/kostoff/index.html, 1997q.

Kraemer, H. C. (1991). Do We Really Want More "Reliable" Reviewers? Behavioral and Brain Sciences, 14 (1), 152-154

Krawiec, F., "Evaluating and Selecting Research Projects by Scoring", Research Management, Vol. 27, No. 2, March 1984.

Kruytbosch, C., "The Role and Effectiveness of Peer Review", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, John Wiley and Sons, Chichester, UK, 1989

Kwok, K., "A Network Approach to Probabilistic Information-Retrieval", ACM Transactions on Information Systems, 13:3, 1995.

Laband, D. N., "A Citation Analysis of the Impact of Blinded Peer-Review", JAMA, 272:2, 1994.

Laming-D, "Why Is the Reliability of Peer-Review So Low", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 154-155

Lesk, M., "Word-word Associations in Document Retrieval Systems", American Documentation, 20, 1969.

Levine-H Vanek-E Lefferts-G Michener-W Weiker-G, "A Peer-Review Process to Assess the Quality of Graduate Medical-Education", JOURNAL OF MEDICAL EDUCATION, 1988, Vol 63, Iss 4, pp 288-293

Leydesdorff, L., "Various Methods for the Mapping of Science," Scientometrics, Vol. 11, 1987a.

Leydesdorff, L., "Words and Co-words as Indicators of Intellectual Organization," Research Policy, Vol. 18, 1989.

Leydesdorff, L., "Words and Co-words as Indicators of the Intellectual Organization of the Sciences," Presented to the EASST workshop in Amsterdam, December 1987b.

Libbey, M. and Zaltman, G. "The Role and Distribution of Written Informal Communication in Theoretical High Energy Physics," American Institute of Physics, New York, 1967.

Liberatore, M.J., "An Incremental Approach for R&D Project Planning and Budgeting", Research Management, March 1981.

Liberatore, M.J., "An Extension of the Analytic Hierarchy Process for Industrial R&D Project Selection and Resource Allocation", IEEE Transactions on Engineering Management, Vol. 34, No. 1, February 1987.

Link, A., "Methods for Evaluating the Return on R&D Investments", in Assessing R&D Impacts: Method and Practice, Bozeman, B. and Melkers, J., Eds. (Kluwer Academic Publishers, Norwell, MA) 1993.

Linstone, H. A., "Multiple Perspectives: Concept, Applications, and User Guidelines," Systems Practice, 2:3, 1989.

Lockett, A.G. and Gear, A.E., "An Approach to Dynamic Modeling in R&D", Proceedings 38th Meeting Operations Research Society, Detroit, Michigan, October, 1970.

Logsdon, J.M. and Rubin, C.B., "An Overview of Federal Research Evaluation Activities", Report, The George Washington University, Wash., D. C., April 1985. See also J. M. Logsdon and C. B. Rubin, "Federal Research Evaluation Activities", Cambridge, MA, Abt

Associates, 1985.

Luce-RD, "Reliability Is Neither to Be Expected Nor Desired in Peer-Review", BEHAVIORAL AND BRAIN SCIENCES, 1993, Vol 16, Iss 2, pp 399-400

Lundberg-GD Williams-E, "The Quality of a Medical Article - Thank-You to Our 1990 Peer Reviewers", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1991, Vol 265, Iss 9, pp 1161-1162

Luukkonen-Gronow, T. 1990 Quality evaluations in the management of basic and applied research. Research Policy. 19, 357-368.

Luukkonen, T., "Bibliometrics and Evaluation of Research Performance", Annals of Medicine, Vol. 22, No. 3, 1990a.

Luukkonen, T., and Stahle, B., "Evaluation of Research Fields - Scientists' Views", Nord 1993: 15, Nordic Council of Ministers, Copenhagen, 1993.

Luukkonen, T., and Stahle, B., "Quality Evaluations in the Management of Basic and Applied Research", Research Policy, 19, 1990b.

Luukkonen, T., Persson, O., and Sivertsen, G., "Understanding Patterns of International Scientific Collaboration," Science, Technology, and Human Values, Vol. 17, No. 1, January 1992.

Luukkonen-Gronow, T., "Scientific Research Evaluation: A Review of Methods and Various Contexts of Their Application," R&D Management, 17:3, 1987.

Maarek, Y. S., and Smadja, F. A., "Full Text Indexing Based on Lexical Relations, An Application: Software Libraries," Proceedings of the 12th International SIGIR, Conference on Research and Development in Information Retrieval, Cambridge, MA, 1989.

MacRoberts, M., and MacRoberts, B., "Problems of Citation Analysis", Scientometrics, 36:3, July-August, 1996.

MacRoberts, M.H., and MacRoberts, B.R., "Problems of Citation Analysis: A Critical Review," Journal of the American Society for Information Science, 40:5, 1989.

Madey, G.R. and Dean, B.V., "Strategic Planning for Investment in R&D using Decision Analysis and Mathematical Programming", IEEE Transactions on Engineering Management, Vol. EM-32, No. 2, 1985.

Maher, P.M. and Rubenstein, A.H., "Factors Affecting Adoption of a Quantitative Method for R&D Project Selection", Management Science, Vol. 21, No. 2, pp. 119-129, October 1974.

Mandakovic, T. and Souder, W.E., "An Interactive Decomposable Heuristic for Project Selection", Management Science, Vol. 31, No. 10, October 1985.

Mansfield, E., "Academic Research and Industrial Innovation," Research Policy, Vol. 20, 1991.

Mansfield, E., "Basic Research and Productivity Increase in Manufacturing," The American Economic Review, Vol. 70, No. 5, December 1980.

Maron, M. and Kuhns, J., "On Relevance, Probabilistic Indexing, and Information Retrieval", Journal of the ACM, 7, 1960.

Marsh H W & Ball S (1989) The peer review process used to evaluate manuscripts submitted to academic journals: Interjudgmental reliability. Journal of Experimental Education 57, No. 2, 151-169.

Marshall-E, "Peer-Review - Despite Anxiety, NIH Begins Merging

Neuroscience Panels", SCIENCE, 1996, Vol 273, Iss 5276, pp 731-731

Martin, B. and Irvine, J., "Assessing Basic Research: Some Partial Indicators of Scientific Progress in Radio-Astronomy," Research Policy, 12, 1983.

Martin, B. R. et al, "Recent trends in the Output and Impact of British Science", Science and Public Policy, 17:1, Feb., 1990.

Martin, B. R. & Irvine, J. 1981 Internal criteria for scientific choice:an evaluation of research in high-energy physics using electron accelerators. Minerva. 19, 408-432.

Mays, E., Damerau, F., and Mercer, R., "Context Based Spelling Correction," IBM Nat'l Language ITL, IBM, Paris, France, Mar 1990.

McAllister, P.R., Narin, F., and Corrigan, J.G., "Programmatic Evaluation and Comparison Based on Standardized Citation Scores", IEEE Transactions on Engineering Management, Vol. EM-30, No. 4, November 1983.

McCardell, R., "Lexical Selection for Natural Language Generation," Technical Report, Computer Science Department, Univ of Md, 1988.

McDonald James E., Plate, Tony A., and Schvaneveldt, Roger W., "Using Pathfinder to Extract Semantic Information From Text," in: Schvaneveldt, Roger W.,ed., Pathfinder Associative Networks: Studies in Knowledge Organization, Ablex Publishing Corp., 1990.

McGuire, P.E., "Evaluating New Product Proposals", New York: New York Conference Board, Inc., 1973.

McKinnon, A., "From Co-occurrences to Concepts," Computers and the Humanities, Vol. 11, Pergamon Press, 1977.

Mcnutt-RA Evans-AT Fletcher-RH Fletcher-SW, "The Effects of Blinding on the Quality of Peer-Review - A Randomized Trial", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1990, Vol 263, Iss 10, pp 1371-1376

Melcuk, I. A., "Meaning-Text Models: A Recent Trend in Soviet Linguistics," The Annual Review of Anthropology, 1981.

Menke, M.M., "Using Decision Analysis to Determine R&D's Value: Part 1", Inside R&D's Managing Innovation, March 9, 1983.

Miller, R., "The Influence of Primary Task on R&D Laboratory Evaluation: A Comparative Bibliometric Analysis", R&D Management, 22:1, 1992.

Moed, H.F. and Van Raan, A.F.J., "Indicators of Research Performance: Applications in University Research Policy," in: Van Raan, A.F.J., ed., Handbook of Quantitative Studies of Science and Technology, North Holland, 1988

Mokrasch-LC, "Peer-Review Ethics", SCIENTIST, 1988, Vol 2, Iss 16, pp 14-14

Moore, J.R. and Baker, N.R., "Computational Analysis of Scoring Models for R&D Project Selection", Management Science, Vol. 16, No. 4, pp. 212-232, December 1969.

Moran-G, "Ethical Questions About Peer-Review", JOURNAL OF MEDICAL ETHICS, 1992, Vol 18, Iss 3, pp 160-160

Mottley, C.M. and Newton, R.D., "The Selection of Projects for Industrial Research", Operations Research, Vol. 7, November-December 1959.

Mullins, N., "Evaluating Research Programs: Measurement and Data

Sources", Science and Public Policy, Vol. 14, No. 2, April 1987.

Mullins, N., Snizek, W., and Oehler, K., "The Structural Analysis of a Scientific Paper," in: Van Raan, A.F.J.,. ed., Handbook of Quantitative Studies of Science and Technology, North Holland, 1988

Narin, F., "Bibliometric Techniques in the Evaluation of Research Programs", Science and Public Policy, 14:2, April 1987b.

Narin, F., "Evaluative Bibliometrics: The Use of Publication and Citation Analysis in the Evaluation of Scientific Activity" (monograph), NSF C-637, National Science Foundation, Contract NSF C-627, NTIS Accession No. PB252339/AS, March 31, 1976.

Narin, F., "In the Realm of Technology, Asia Looms ever Larger: Patent Citation as Measures of Corporate and National Strength", Presented at Stanford University, October 29, 1992a.

Narin, F., "Patent Citation Indicators in Strategic Planning", Presented at Symposium on Evaluation of Scientific-Technological Performance, Jahrhunderthalle Hoechst, Frankfurt, Germany, October 5, 1990.

Narin, F., "Technological Evaluation of Industrial Firms by Means of Patent Investigation", Presented at VPP Professional Meeting, Nurnberg, Germany, November 13, 1992b.

Narin, F., "The Impact of Different Modes of Research Funding", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, John Wiley and Sons, Chichester, UK, 1989.

Narin, F., and Olivastro, D., "The Technological Utilization of European Science," Presented at Joint EC-Leiden Conference on Science and Technology Indicators, Leiden, 23-25 October 1991.

Narin, F., and Olivastro, D., "Technology Indicators Based on Patents and Patent Citations", in: Van Raan, A.F.J., Ed., Handbook of Quantitative Studies in Science and Technology, Elsevier Science Publishers, Amsterdam, 1988c.

Narin, F., and Olivastro, D., "Identifying Areas of Leading Edge Japanese Science and Technology", Final Report, NSF Contract No. SRS-8507306, April 1988a.

Narin, F. and Olivastro, D., "Status Report-Linkage between Technology and Science," Research Policy, 21:3, June, 1992.

Narin, F., Carpenter, M. P., and Woolf, P., "Technological Performance Assessments Based on Patents and Patent Citations", IEEE Transactions on Engineering Management, EM-31, 4, Nov. 1984.

Narin, F., Noma, E., and Perry, R., "Patents as Indicators of Corporate Technological Strength", Research Policy, Vol. 16, 1987a.

Narin, F., Olivastro, D., and Stevens, K. A., "Bibliometrics - Theory, Practice, and Problems", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Narin, F., Rosen, M., and Olivastro, D., "Patent Citation Analysis: New Validation Studies and Linkage Statistics", in: Van Raan, A.F.J., Nederhof, A.J., and Moed, H.F., Eds., Science Indicators: Their Use in Science Policy and Their Role in Science Studies, DSWO Press, the Netherlands, November 1988b.

NAS, "The Government Role in Civilian Technology: Building a New Alliance", Committee on Science, Engineering, and Public Policy,

National Academy of Sciences, National Academy Press, 1992.

Neetens-A, "Should Peer Reviewers Shed the Mask of Anonymity", NEURO-OPHTHALMOLOGY, 1995, Vol 15, Iss 3, pp 109-109 .

Nelson, K. S., Tomsyck, J. P., and Sorensen, D. P., "Industrial R&D Program Evaluation Techniques", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Nicholson, R. S., "Improving Research Through Peer Review," National Research Council, 1987, NTIS Acc. No. PB88-163571.

Nirenburg, S., "Lexicon Building in Natural Language Processing," Program and Abstracts of the 15th International ALLC, Conference of the Association for Literary and Linguistic Computing, Jerusalem, Israel, June 1988.

NIST, "An Assessment of the National Institute of Standards and Technology Programs: FY 1990," Board on Assessment of NIST Programs, National Research Council, National Academy Press, 1991b.

NIST, "Annual Report, 1990," Visiting Committee on Advanced Technology, January 1991a.

Nonaka, I. The Knowledge-Creating Company. Harvard Business Review, November-December, 1991.

NSF, "Science and Engineering Indicators - 1996", National Science Board Report NSB 96-21, GPO, Wash., D.C., 1996.

Nutt, A.B., "An Approach to Research and Development Effectiveness", IEEE Transactions on Engineering Management, September 1965.

Nylenna-M Riis-P Karlsson-Y, "Multiple Blinded Reviews of the 2 Manuscripts - Effects of Referee Characteristics and Publication Language", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION, 1994, Vol 272, Iss 2, pp 149-151

Oberski, J. E. J., "Some Statistical Aspects of Co-citation Cluster Analysis and a Judgement by Physicists," in Van Raan, A.F.J. (ed.), Handbook of Quantitative Studies of Science and Technology, North Holland, 1988.

Odeyale, C. O. and Kostoff, R. N., "R&D Management Expert Networks: II. Prototype Construction and Validation", HEURISTICS, the Journal of Knowledge Engineering and Technology, 7:1, 1994b.

Odeyale, C. O., "Design and Development of a Knowledge-Based System for Effective and Unbiased Military Biomedical R&D Management," Ph. D. Dissertation, Walden University, 1993.

Odeyale, C. O. and Kostoff, R. N., "R&D Management Expert Networks: I. Knowledge Representation and Inference Strategies", HEURISTICS, the Journal of Knowledge Engineering and Technology, 7:1, 1994a.

ONR, "ONR Selected Accomplishments 1992", Office of Naval Research, 1992.

ONR, Department of the Navy In-House Laboratory Independent Research Annual Report for FY1995, December 1996.

Ormala, E., "Impact Assessment: European Experience of Qualitative Methods and Practices", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Ormala, E., "Nordic Experiences of the Evaluation of Technical

Research and Development", Research Policy, 18, 1989.

OTA, "Federally Funded Research: Decisions for a Decade", U.S.Congress, Office of Technology Assessment, OTA-SET-490 (Wash., DC: U. S. GPO, May 1991).

OTA, "Research Funding as an Investment: Can We Measure the Returns", U. S. Congress, Office of Technology Assessment, OTA-TM-SET-36 (Wash., DC: U. S. GPO, April 1986).

OTA, "The Defense Technology Base: Introduction and Overview", U.S. Congress, Office of Technology Assessment, (OTA-ISC-374, March 1988) and "Holding the Edge: Maintaining the Defense Technology Base" (OTA-ISC-420) Wash., DC: U. S. GPO, April 1989.

Palli-D Confortini-M Biggeri-A Russo-A Cariaggi-P , Carozzi-F Minuti-PA, "A Quality-Control System Involving Peer-Review of Abnormal Cervical Smears", CYTOPATHOLOGY, 1993, Vol 4, Iss 1, pp 17-25

Paolini, A., Jr. and Glaser, M.A., "Project Selection Methods that Pick Winners", Research Management, Vol. 20, pp. 26-29, 1977.

Pavitt, K., "What Makes Basic Research Economically Useful", Research Policy, 20, 1991.

Peters D P & Ceci S J (1982) Peer-review practices of psychology journals: The fate of published articles, submitted again. The Behavioral and Brain Sciences **5**, 187-195. EX

Peters, H. and Van Raan, A., "Co-Word Based Science Maps of Chemical Engineering," Research Report to the Netherlands Foundation for Technological Research (CWTS-91-03), April 1991.

Plebani, L.P. and Jain, H.K., "Evaluating Research Proposals with Group Techniques", Research Management, Vol. 24, pp. 34-38, 1981.

Pound, W.H., "Research Project Selection: Testing a Model in the Field", IEEE Transactions on Engineering Management, Vol. EM-11, March 1964.

Rainville-EC Possidente-CJ Harry-DJ, "A Peer Review-Based Quality Assurance System", AMERICAN JOURNAL OF HOSPITAL PHARMACY, 1991, Vol 48, Iss 7, pp 1531-1533

Ramasarma-T, "The Peer Reviewer Should Be Fair, Secret or Otherwise", FASEB JOURNAL, 1995, Vol 9, Iss 14, pp 1500-1500

Ramsay-AD Gallagher-PJ, "Quality-Control of Surgical Pathology by Peer-Review - The Southampton Experience", JOURNAL OF PATHOLOGY, 1989, Vol 158, Iss 4, pp A343-A343

Ramsey, J.E., "Research and Development: Project Selection Criteria", UMI Research Press, 1978.

Rip, A., "Mapping of Science: Possibilities and Limitations," in: Van Raan, A.F.J., ed., Handbook of Quantitative Studies of Science and Technology, North Holland, 1988

Rip, A., and Courtial, J.P., "Co-word Maps of Biotechnology: An Example of Cognitive Scientometrics," Scientometrics, Vol. 6, No. 6, 1984.

Robb, W. L., "Evaluating Industrial R&D", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Roberts, J.C., et al, "Effects of Peer-Review and Editing on the Readability of Articles Published in Annals of Internal Medicine",

JAMA, 272:2, 1994.

Robertson, S. and Sparck Jones, K., "Relevance Weighting of Search Terms". JASIS, 27, 1976.

Rocchio, J., "Relevance Feedback in Information Retrieval", The Smart System-Experiments in Automatic Document Processing, Prentice Hall, Inc., Englewood Cliffs, NJ, 1971.

Roediger-HL, "Is Unreliability in Peer-Review Harmful", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 159-159

Roessner, J. D., "The Multiple Functions of Formal Aids to Decision Making in Public Agencies", IEEE Transactions on Engineering Management, EM-32,:3, August, 1985.

Rosen, E.M. and Souder, W.E., "A Method for Allocating R&D Expenditures", IEEE Transactions on Engineering Management, Vol. EM-12, pp. 87-93, September 1965.

Rosenblatt, A. & Kirk, S. A. (1980). Recognition of Authors in Blind Review of Manuscripts. Journal of Social Service Research, 3 (4), 383-394

Rosenthal-GE Hom-D Landefeld-CS, "Preventable Hospital Death from Myocardial-Infarction - Is Peer-Review Reliable", CLINICAL RESEARCH, 1990, Vol 38, Iss 2, pp A229-A229

Rosenthal-R, "Some Indexes of the Reliability of Peer-Review", BEHAVIORAL AND BRAIN SCIENCES, 1991, Vol 14, Iss 1, pp 160-160

Roy, R., "An Alternative Funding Mechanism," Science, 211: 1377, 1981.

Roy, R., "Funding Science: The Real Defects of Peer Review and an Alternative to It", Science, Technology, and Human Values, 10:3, 1985.

Rubenstein, A. H. and Geisler, E., "Evaluating the Outputs and Impacts of R&D/Innovation," International Journal of Technology Management, 6:3/4, 1991.

Rubenstein, A. H. and Geisler, E., "The Use of Indicators and Measures of the R&D Process in Evaluating Science and Technology Programs," In: J. Roessner (Editor), Government Innovation Policy, St. Martins Press, 1988.

Rubenstein, A. H., Geisler, E. and Abeysinghe, R., "Industrial Practices of Research Conversion and Technology Transfer", Journal of Technology Transfer, Fall, 1997.

Rubin-HR Redelmeier-DA Wu-AW Steinberg-EP, "How Reliable Is Peer-Review of Scientific Abstracts - Looking Back at the 1991 Annual-Meeting of the Society of General Internal-Medicine", CLINICAL RESEARCH, 1992, Vol 40, Iss 2, pp A604-A604

Salasin, J. et al, "The Evaluation of Federal Research Programs", MITRE Technical Report MTR-80W123, June 1980.

Salton, G. :Relevance Feedback and the Optimization of Retrieval Effectiveness", The Smart System-Experiments in Automatic Document Processing, Prentice Hall, Inc., Englewood Cliffs, NJ, 1971.

Salton, G., "Automatic Text Processing: The Transformation, Analysis, and Retrieval of Information by Computer," Addison-Wesley Publishing Company, New York, NY, 1989.

Salton, G., and McGill, M. J., "Introduction to Modern Information Retrieval," Computer Series, McGraw Hill, New York, NY,

1983.

Salton, G. and Buckley, C., "Improving Retrieval Performance by Relevance Feedback", JASIS, 41:4, 1990.

Salton, G., Fox, E., and Vorhees, E., "Advanced Feedback Methods in Information Retrieval", JASIS, 36, 1985.

Schubert, A., and Braun, T., "Three Scientometric Etudes on Developing Countries as a Tribute to Michael Moravcsik," Scientometrics, 23:1, 1992.

Schubert, A., and Braun, T., "Relative Indicators and Relational Charts for Comparative Assessment of Publication Output and Citation Impact," Scientometrics, 9:5-6, 1986.

Schubert, A., and Braun, T., "Cross-Field Normalization of Scientometric Indicators", Scientometrics, 36:3, 1996.

Schubert, A. and Braun, T., "Reference Standards for Citation Based Assessments", Scientometrics, 26:1, 1993.

Schubert, A., et al, "World Flash on Basic Research," Scientometrics, 12:5-6, 1987.

Schubert, A., et al, "Against Absolute Methods: Relative Scientometric Indicators and Relational Charts as Evaluation Tools," in A. F. J. Van Raan (ed), Handbook of quantitative Studies of Science and Technology, Elsevier Science Publishers B.V., North Holland, 1988.

Schwartz, S.L. and Vertinsky, I., "Multiattribute Investment Decision: A Study of R&D Project Selection", Management Science, Vol. 24, No. 3, pp. 285-301, November 1977.

SCIENCE, "Top 10 U. S. Universities in Clinical Medicine Research, 1990-1994", Science, Vol. 269, 1 September 1995, p. 1223.

Shaughnessy-AF, "Blind Peer-Review of Journal Articles - Comment", DRUG INTELLIGENCE & CLINICAL PHARMACY, 1988, Vol 22, Iss 12, pp 1006-1006

Shrum, W. and Mullins, N., "Network Analysis in the Study of Science and Technology," in: Van Raan, A.F.J., ed., Handbook of Quantitative Studies of Science and Technology, North Holland, 1988

Silverman, B.G., "Project Appraisal Methodology: A Multidimensional R&D Benefit/ Cost Assessment Tool", Management Science, Vol. 27, No. 7, pp. 802-824, 1981.

Sly-RM, "Blinding Reviewers Improves Peer-Review", ANNALS OF ALLERGY, 1990, Vol 65, Iss 4, pp 243-243

Smadja, F., "Extracting Collocations from Text. An Application: Language Generation," PhD Thesis, Columbia University, 1991.

Smadja, F., "Lexical Cooccurrence: The Missing Link in Language Acquisition," 15th International ALLC, Conference of the Association for Literary and Linguistic Computing, Jerusalem, Israel, 1988.

Smadja, F., "Macrocoding the Lexicon with Cooccurrence Knowledge for Language Generation," Columbia University, Computer Science Department, Technical Report CUCS-630-89, 1989.

Small, H., "A Co-citation Model of a Scientific Speciality: A Logitudinal Study of Collagen Research," Social Studies of Science, 7, 1977.

Small, H., "Cited Documents as Concept Symbols," Social Studies of Science, 8, 1978.

Small, H., "Co-citation in the Scientific Literature: A New

Measure of the Relationship Between Two Documents," Journal of the American Society for Information Science, 24, July/ August, 1973.

Small, H. and Sweeney, E., "Clustering the Science Citation Index using Co-citations," Scientometrics, 7, 1985a.

Small, H. and Greenlee, E., "Citation Context Analysis of a Co-citation Cluster: Recombinant DNA," Scientometrics, 2, 1980.

Small, H. and Greenlee, E., "Collagen Research in the 1970s," Scientometrics, 10, 1986.

Small, H., Sweeney, E., and Greenlee, E., "Clustering the Science Citation Index using Co-citations. II. Mapping Science," Scientometrics, 8, 1985b.

Smeaton, A. and Van Rijsbergen, C., "The Retrieval Effects of Query Expansion on a Feedback Document Retrieval System", Computer Journal, 26, 1983.

Smith-R, "Research Policy - Problems with Peer-Review and Alternatives", BRITISH MEDICAL JOURNAL, 1988, Vol 296, Iss 6624, pp 774-777

Souder, W.E., "Achieving Organizational Consensus with Respect to R&D Project Selection Criteria", Management Science, Vol. 21, No. 6, February 1975.

Souder, W.E., "Analytical Effectiveness of Mathematical Models for R&D Project Selection", Management Science, Vol. 29, No. 8, April 1973.

Souder, W.E., "System for Using R&D Project Evaluation Methods", Research Management, Vol. 21, pp. 29-37, 1978.

Southgate-DAT, "The Ethics of Peer-Review", BRITISH JOURNAL OF NUTRITION, 1992, Vol 67, Iss 3, pp 303-304

Spann, M., Adams, M., Souder, W., "Measures of Technology Transfer Effectiveness: Key Dimensions and Differences in Their Use by Sponsors, Developers, and Adopters," IEEE Transactions on Engineering Management, vol 42, no. 1, Feb 1995, pp.19-29

Sparck Jones, K., "Automatic Keyword Classification for Information Retrieval," Butterworths, London, 1971.

Sparck Jones, K. and Tait, J. I., "Automatic Search Variant Generation," Journal of Documentation, Vol. 40, No. 1, March 1984.

Speck, W. B., "Publication Peer Review", Westport, CT.

Spink,A., "Term Relevance Feedback and Mediated Database Searching - Implications for Information-Retrieval Practice and Systems-Design", Information Processing & Management, 31:2, 1995.

Spitzer-WO, "Is Peer-Reviewing Fair - Comment", JOURNAL OF CLINICAL EPIDEMIOLOGY, 1994, Vol 47, Iss 7, pp 819-820

Stahl, M.J. and Harrel, A.M., "Identifying Operative Goals by Modeling Project Selection Decisions in Research and Development", IEEE Transactions on Engineering Management, Vol. EM-30, No. 4, November 1983.

Stamps A E III (1997a) Advances in peer review research: An introduction. Science and Engineering Ethics , 3:1 1997.

Stamps, A. E., "Using a Dialectical Scientific Brief in Peer Review", Science and Engineering Ethics, 3:1, 1997b.

Stiles, H., "The Association Factor in Information Retrieval", Journal of the ACM, 8, 1961.

Stull, G. R. (1989). Peer-Review Process Is Key to Quality

Publication Ceramic Bulletin, 68 (4), 850-852

Sutherland-HJ Meslin-EM Dacunha-R Till-JE, "Judging Clinical Research Questions - What Criteria AreUsed", SOCIAL SCIENCE & MEDICINE, 1993, Vol 37, Iss 12, pp 1427-1430

Swanson, D. R., "Fish Oil, Raynaud's Syndrome, and Undiscovered Public Knowledge", Perspectives in Biology and Medicine, 30:1, 1986.

Taylor, B.W., Moore, L.J. and Clayton, E.R., "R&D Project Selection and Manpower Allocation with Integer Nonlinear Goal Programming", Management Science, 28:10, 1982.

Terleckyj, N., "Measuring Economic Effects of Federal R&D Expenditures: Recent History with Special Emphasis on Federal R&D Performed in Industry", Presented at NAS Workshop on 'The Federal Role in Research and Development', November 1985.

Terleckyj, N., "State of Science and Research: Some New Indicators", Westview Press, Boulder, CO, 1977.

Themelis, N.J., "Evaluation and Selection of Projects in Industrial Research", Journal of Management, pp. 15-20, January 1976.

Thomas, C., "Strategic Technology Assessment, Future Products and Competitive Advantage," International Journal of Technology Management, Special Publication on Technology Assessment, pp. 651-666, 1996.

Tijssen, R. and Van Raan, A., "Mapping Changes in Science and Technology", in: Kostoff, R. N., (ed.), Evaluation Review, Special Issue on Research Impact Assessment, 18:1, February 1994.

Tipping, J. W., Industrial Research Institute, Telephone conversation, December 1993.

Turner, W.A., Chartron, G., Laville, F., and Michelet, B., "Packaging Information for Peer Review: New Co-Word Analysis Techniques," in: Van Raan, A.F.J., ed., Handbook of Quantitative Studies of Science and Technology, North Holland, 1988

Van de Ven, A. and Delbecq, A.L., "Nominal versus Interacting Group Processes for Committee Decision Making Effectiveness", Acad. Manag. J., pp. 203-212, June 1971.

Van den Beemt, F.C.H.D. and Le Pair, C., "Grading the Grain: Consistent Evaluation of Research Proposals", Research Evaluation, 1:1, 1991.

Van den Beemt, F.C.H.D, "The Right Mix: Review by Peers as well as by Highly Qualified Persons (Non-Peers)", Australian Research Council Commissioned Report: "Peer Review Process" No.54 (1997), 153-164.

Van Raan, A. and Tijssen, R., "The Neural Net of Neural Network Research: An Exercise in Bibliometric Mapping," Centre for Science and Technology Studies, University of Leiden, 1991.

Van Raan, A.F.J., "Evaluation of Research Groups", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, John Wiley and Sons, UK, 1989.

Van Rijsbergen, C., "Information Retrieval", Butterworths, London, 1979.

Van Rijsbergen, K., "Information Retrieval," 2nd Edition, Butterworths, London, 1979.

Van Vianen, B. G., Moed, H. F., and Van Raan, A. F. J., "An Exploration of the Science Base of Recent Technology," Science

Policy, Vol. 19, 1990.
Vandenbroucke-JP, "Can the Quality of Peer-Review Be Measured - Comment", JOURNAL OF CLINICAL EPIDEMIOLOGY, 1994, Vol. 47, Iss 7, pp 821-822
Vanston, J.H., Jr. et al, "PAF - A New Probabilistic Computer-based Technique for Technology Forecasting", Technology Forecasting for Social Change, Vol. 10, 1977.
Wakefield-DS Helms-CM, "The Role of Peer-Review in a Health-Care Organization Driven by Tqm/Cqi", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT, 1995, Vol 21, Iss 5, pp 227-231
Wallmark, J.T., and Sedig, K.G., "Quality of Research Measured by Citation Method and by Peer Review - A Comparison", IEEE Transactions on Engineering Management, EM-33:4, November 1986.
Watters, L.D., "Research and Development Project Selection: Interdependence and Multiperiod Probabilistic Budget Constraints", Ph. D. Dissertation, Arizona State Univ., Tempe, Arizona, 1967.
Weinberg, A. M. 1964 Criteria for scientific choice II: the two cultures.Minerva. 4, 5-14.
Weinberg, A.M., "Criteria for Evaluation, A Generation Later", in: Evered, David and Harnett, Sara, Eds., The Evaluation of Scientific Research, Wiley, Chichester, UK, 1989.
White, H.D., and McCain, K.W., "Bibliometrics," in: Williams, M.E. (ed.), Annual Review of Information Science and Technology, 24, 1989.
Whittaker, J., "Creativity and Conformity in Science: Titles, Keywords and Co-word Analysis," Social Studies of Science, 19,1989.
Winkofsky, E.P., Mason, R.M. and Souder, W.E., "R&D Budgeting and Project Selection: A Review of Practices and Models", TIMD Studies Management Science, 1980.
Wick-G, "The Peer-Review System - Still No Alternative in Sight", INTERNATIONAL ARCHIVES OF ALLERGY AND IMMUNOLOGY, 1996, Vol 109, Iss 1, pp 1-2
Wicks-S, "Peer-Review and Quality-Control in Higher-Education", BRITISH JOURNAL OF EDUCATIONAL STUDIES, 1992, Vol 40, Iss 1, pp 57-68
Winkofsky, E.P., et al, "A Decision Process Model of R&D Resource Allocation in Hierarchical Organizations", Management Science, Vol. 27, No. 3, pp. 268-283, 1981.
Wirt, J.G. et al, "R&D Management: Methods Used by Federal Agencies", Rand Report No. R-1156-HEW, January 1974.
Wood, F. Q. "The Peer Review Process", Australian Research Council, Report Number 54, January 1997.
Xu, J. and Croft, W.B., "Query Expansion Using Local and Global Document Analysis", in Proceedings of the 19th International Conference on Research and Development in Information Retrieval (SIGIR'96), Zurich, Switzerland, 1996.
Zurcher, R. J. and Kostoff, R. N., "Modeling Technology Roadmaps", Journal of Technology Transfer, 22:3, Fall 1997.

X. SUGGESTED FURTHER READING

There are three special journal issues which have been assembled in recent years dealing with the broad area of research impact

assessment [Kostoff, 1994a, 1996c, 1997j]. These three form a trilogy, and are recommended for the reader interested in pursuing the topic further. Their tables of contents follow.. In addition, the other two documents on peer review [Kostoff, 1997i] and roadmaps [Kostoff, 1997p] located at this web site complement the three special issues.

X-A. The focus of the following special issue of the journal Scientometrics on quantitative research measures is especially useful for managers and analysts involved in identifying U. S. agency responses to the requirements of the Government Performance and Results Act of 1993 (GPRA).

PERFORMANCE MEASURES FOR GOVERNMENT-SPONSORED RESEARCH, Special Issue of the Journal SCIENTOMETRICS, Kostoff, R. N. (ed.), Vol. 36, No. 3, July-August 1996.

TABLE OF CONTENTS:

*CONFORMING THE GOVERNMENT R&D FUNCTION WITH THE REQUIREMENTS OF THE GOVERNMENT PERFORMANCE AND RESULTS ACT: PLANNING THE UNPLANNABLE? MEASURING THE UNMEASURABLE?
Edward A. Brown (U. S. Army Research Laboratory)

X-B. The following special issue of Evaluation Review covers many of the diverse aspects of research impact assessment.

RESEARCH IMPACT ASSESSMENT, Special Issue of the Journal EVALUATION REVIEW, Kostoff, R.N., (ed.), Vol. 18, No. 1, February 1994.

TABLE OF CONTENTS:

X-C. The following special issue of the Journal of Technology Transfer focuses on the problem of converting science to technology.

ACCELERATING THE CONVERSION OF SCIENCE TO TECHNOLOGY, Special Issue of the Journal of <u>TECHNOLOGY TRANSFER</u>, Kostoff, R.N., (ed.), Vol. 22 , No. 3, Fall 1997.

TABLE OF CONTENTS:

X-D. The following journal articles, listed alphabetically by author, are also suggested for further reading.

Aaronson-D, "Computer-Based Driving Systems for Research, Assessment, and Advisement - An Introduction", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS,1994, Vol 26, Iss 2, pp 181-182

Aaronson-D Eberhard-J, "An Evaluation of Computer-Based Driving Systems for Research, Assessment, and Advisement", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS,1994, Vol 26, Iss 2, pp 195-197

ABA, "Universal Citation Systems", ABA JOURNAL 1996, Vol 82, Iss JUL, pp 74-74

Abbott-A, "Funding Cuts Put Pressure on Peer-Review", NATURE

1996, Vol 383, Iss 6601, pp 567-567

Abbott-A, "Italian Peer-Review Under Pressure", NATURE,1992, Vol 358, Iss 6381, pp 9-9

Abby-M Massey-MD Galandiuk-S Polk-HC, "Peer-Review Is an Effective Screening Process to Evaluate Medical Manuscripts", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 105-107

Abdullah-SB Lancaster-FW, "The Contribution of Scientists to the Popular Literature, Their Role As Expert Witnesses, and Their Influence on Their Peers - A Case-Study in the Field of Acid-Rain", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 55-64

Abrams-PA, "The Predictive Ability of Peer-Review of Grant Proposals - The Case of Ecology and the United-States-National-Science-Foundation", SOCIAL STUDIES OF SCIENCE,1991, Vol 21, Iss 1, pp 111-132

Abt-HA, "Publication Practices in Various Sciences", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 441-447

Abt-HA, "Report on the Manuscript Entitled British Science in the 1980s - Has the Relative Decline Continued", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 57-58

Abt-HA, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1408-1409

Acker-JR, "A Different Agenda - The Supreme-Court, Empirical-Research Evidence, and Capital-Punishment Decisions, 1986-1989", LAW & SOCIETY REVIEW,1993, Vol 27, Iss 1, pp 65-88

ACS, "Substances Through Citation Links", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 1996, Vol 211, Iss MAR, pp 51-CINF

Adair-JG, "The Research Environment in Developing-Countries - Contributions to the National-Development of the Discipline", INTERNATIONAL JOURNAL OF PSYCHOLOGY 1995, Vol 30, Iss 6, pp 643-662

Adams-J Griliches-Z, "Measuring Science - An Exploration", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 1996, Vol 93, Iss 23, pp 12664-12670

Adams-KM, "Peer-Review - An Unflattering Picture", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 135-135

Adams-MD Venter-JC, "Should Non-Peer-Reviewed Raw DNA-Sequence Data Release Be Forced on the Scientific Community", SCIENCE 1996, Vol 274, Iss 5287, pp 534-536

Adamson-I, "Access and Retrieval of Information as Coordinates of Scientific Development and Achievement in Nigeria", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 191-199

Adebodun-F, "Peer-Review Reform", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 7, pp 4+

Adler-RW Hall-RH, "The Effect of Accounting and Performance Indicators on Public Accountants Perceptions of Organizational Decline", REVUE CANADIENNE DES SCIENCES DE L ADMINISTRATION- CANADIAN JOURNAL OF ADMINISTRATIVE SCIENCES 1996, Vol 13, Iss 3, pp 189-206

Agell-G, "Citation Awarding the Honorary Degree of Doctor of Art-Therapy to Kramer,Edith, ATR-BC, Hlm", AMERICAN JOURNAL OF ART THERAPY 1996, Vol 35, Iss 2, pp 38-38

Aguillo-IF, "Increasing the Between-Year Stability of the Impact Factor in the Science-Citation-Index", SCIENTOMETRICS 1996, Vol 35,

Iss 2, pp 279-282

Aiginger-K, "Small Firms and the Merger Mania - Reply", SMALL BUSINESS ECONOMICS,1993, Vol 5, Iss 4, pp 323-330

Ajzenbergselove-F, "38 Years with the Light-Nuclei - A Citation-Classic Commentary on Energy-Levels of Light-Nuclei, A=5-10, A=11-12, A=13-15, A=16-17, A=18-20 by Ajzenbergselove,F. and Lauritsen,T.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 18, pp 10-10

Alassaf-AF, "Health-Care Outcomes Management and Quality Improvement", JOURNAL OF THE ROYAL SOCIETY OF HEALTH 1996, Vol 116, Iss 4, pp 245-252

Albers-LL Murphy-PA, "Evaluation of Research Studies .3. Statistical Significance Testing", JOURNAL OF NURSE-MIDWIFERY,1993, Vol 38, Iss 1, pp 51-53

Albert-MB Avery-D Narin-F Mcallister-P, "Direct Validation of Citation Counts As Indicators of Industrially Important Patents", RESEARCH POLICY,1991, Vol 20, Iss 3, pp 251-259

Aldhous-P, "Peer-Review - A Cleanish Bill of Health", NATURE,1991, Vol 349, Iss 6307, pp 272-272

Aleixandre-R Sanchez-JVG Terrada-ML Pinero-JML, "Analysis of the Consumption of Information in the Journal Medicina-Clinica", MEDICINA CLINICA,1994, Vol 103, Iss 7, pp 246-251

Alemi-F Stephens-RC, "Computer Services for Patients - Description of Systems and Summary of Findings", MEDICAL CARE 1996, Vol 34, Iss 10, pp OS1-OS9

Alessi-PJ, "Research on Evaluation of Color Appearance Models for Reflection Print and Self-Luminous Display Image Comparisons", COLOR RESEARCH AND APPLICATION,1994, Vol 19, Iss 1, pp 48-58

Alexander-JC Mabry-RH, "Relative Significance of Journals, Authors, and Articles Cited in Financial Research", JOURNAL OF FINANCE,1994, Vol 49, Iss 2, pp 697-712

Alexander-PA Jetton-TL, "The Role of Importance and Interest in the Processing of Text", EDUCATIONAL PSYCHOLOGY REVIEW 1996, Vol 8, Iss 1, pp 89-121

Alexander-S, "Dynamics on Self Similar Fractals - A Citation-Classic Commentary on Density of States on Fractals - Fractons by Alexander,S., and Orbach,R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 12, pp 8-8

Alger-J, "Can Rank Be Used to Generate a Reliable Author List for Cocitation Studies", COLLEGE & RESEARCH LIBRARIES 1996, Vol 57, Iss 6, pp 567-574

Ali-SN, "Subject Relationship Between Articles Determined by Cooccurrence of Keywords in Citing and Cited Titles", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 3, pp 225-231

Allen-B, "Logical Reasoning and Retrieval Performance", LIBRARY & INFORMATION SCIENCE RESEARCH,1993, Vol 15, Iss 1, pp 93-105

Allen-B Qin-J Lancaster-FW, "Persuasive Communities - A Longitudinal Analysis of References in the Philosophical Transactions of the Royal-Society, 1665-1990", SOCIAL STUDIES OF SCIENCE,1994, Vol 24, Iss 2, pp 279-310

Alloro-G Ugolini-D, "An Automated-Method of Transmitting

Article Requests", ELECTRONIC LIBRARY 1996, Vol 14, Iss 4, pp 311-316

Alston-JM Beach-ED, "Market Distortions and the Benefits from Research into New Uses for Agricultural Commodities - Ethanol from Corn", RESOURCE AND ENERGY ECONOMICS 1996, Vol 18, Iss 1, pp 1-29

Alston-JM Mullen-JD, "Economic-Effects of Research into Traded Goods - The Case of Australian Wool", JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 43, Iss 2, pp 268-278

Altaner-SP, "Distinguished Member Award - Citation to Hower,John", CLAYS AND CLAY MINERALS,1991, Vol 39, Iss 1, pp 110-111

Altman-LK, "The Ingelfinger Rule, Embargoes, and Journal Peer-Review .2.", LANCET 1996, Vol 347, Iss 9013, pp 1459-1463

Altman-LK, "The Ingelfinger Rule, Embargoes, and Journal Peer-Review .1.", LANCET 1996, Vol 347, Iss 9012, pp 1382-1386

Alvares-AP, "Hepatic Cytochrome-P-448 - A Citation-Classic Commentary on Studies on the Induction of Co-Binding Pigments in Liver-Microsomes by Phenobarbital and 3-Methylcholanthrene by Alvares,A.P., Schilling,G., Levin,W. and Kuntzman,R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 38, pp 8-8

Alvarez-JEC Fernandez-MIE Guerrero-AP, "Bibliometric Analysis of the Spanish Research on Endocrinology, 1974-1994", JOURNAL OF PHYSIOLOGY-LONDON 1996, Vol 493P, Iss MAY, pp S123-S123

Alvarez-P Pulgarin-A, "The Rasch Model - Measuring the Impact of Scientific Journals - Analytical-Chemistry", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 6, pp 458-467

AM-J-HOSP-P, "Waivers for Military Use of Investigational Agents - Selected Current Literature Citations on Ethics", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1991, Vol 48, Iss 7, pp 1529-1529

Amato-I, "Materials Science - Roy,Rustum - Pr Is a Better System Than Peer-Review", SCIENCE,1992, Vol 258, Iss 5083, pp 736-736

Amato-I, "Peer-Review or Performance Review - Reply", SCIENCE,1993, Vol 259, Iss 5091, pp 14-14

Amemiya-T, "Writing a Survey - A Citation-Classic Commentary on Qualitative Response Models - A Survey by Amemiya,T.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 14, pp 8-8

Amer-PR Fox-GC, "Estimation of Economic Weights in Genetic-Improvement Using Neoclassical Production Theory - An Alternative to Rescaling", ANIMAL PRODUCTION,1992, Vol 54, Iss JUN, pp 341-350

AMERICAN JOURNAL OF HOSPITAL PHARMACY, Waivers for Military Use of Investigational Agents - Selected Current Literature Citations on Ethics", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1991, Vol 48, Iss 7, pp 1529-1529

AMERICAN PSYCHOLOGIST, Smith,M.Brewster - Citation", AMERICAN PSYCHOLOGIST,1992, Vol 47, Iss 7, pp 853-855

Amsel-A, "The Origin of the Frustration Effect - A Citation-Classic Commentary on Motivational Properties of Frustration .1. Effect on a Running Response of the Addition of Frustration to the Motivational Complex by Amsel,A. and Roussel,J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 10, pp 10-10

Anders-E, "Leonard Medal Citation for Eberhardt,Peter", METEORITICS,1991, Vol 26, Iss 1, pp 70-70

Anderson-A, "No Citation Analyses Please, Were British", SCIENCE,1991, Vol 252, Iss 5006, pp 639-639

Anderson-C, "Peer-Review Loses Out in Congressional Cutting Spree", NATURE,1992, Vol 357, Iss 6374, pp 103-103

Anderson-DR Staufacker-MJ, "The Impact of Worksite-Based Health Risk Appraisal on Health-Related Outcomes - A Review of the Literature", AMERICAN JOURNAL OF HEALTH PROMOTION 1996, Vol 10, Iss 6, pp 499-508

Anderson-F Dalpe-R, "A Profile of Canadian Coal and Petroleum Research Communities", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 447-463

Anderson-J, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 421-422

Anderson-J Williams-N Seemungal-D Narin-F Olivastro-D, "Human Genetic Technology - Exploring the Links Between Science and Innovation", TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT 1996, Vol 8, Iss 2, pp 135-156

Anderson-MB, "In Progress - Reports of New Approaches in Medical-
Education - Annual, Peer-Reviewed Collection of Reports on Innovative Approaches to Medical-Education", ACADEMIC MEDICINE 1996, Vol 71, Iss 5, pp 515-570

Anderson-NR Cunninghamsnell-NA Haigh-J, "Induction Training as Socialization - Current Practice and Attitudes to Evaluation in British Organizations", INTERNATIONAL JOURNAL OF SELECTION AND ASSESSMENT 1996, Vol 4, Iss 4, pp 169-183

Andreasen-NC, "Positive and Negative Symptoms of Psychosis - A Citation-Classic Commentary on Negative Symptoms in Schizophrenia - Definition and Reliability by Andreasen,N.C., and on Negative V Positive Schizophrenia - Definition and Validation by Andreasen,N.C., Olsen,S.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 48, pp 8-8

Andrews-JS, "Does Good Peer-Review Assure Good Epidemiology", JOURNAL OF CLINICAL EPIDEMIOLOGY,1991, Vol 44, Iss S1, pp S131-S134

Androwich-I Hastings-C, "A Practical Approach to Developing System Performance Indicators", NURSING ECONOMICS 1996, Vol 14, Iss 3, pp 174-179

Anfuso-D, "Peer-Review Wards Off Unions and Lawsuits", PERSONNEL JOURNAL,1994, Vol 73, Iss 1, pp 64-64

Anglin-GJ Towers-RL, "Reference Citations in Selected Instructional-Design and Technology Journals, 1985-1990", ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT,1992, Vol 40, Iss 1, pp 40-43

Ankney-CD, "Nutrient Reserves and Clutch Size - A Citation-Classic Commentary on Nutrient Reserves and Reproductive-Performance of Female Lesser Snow Geese by Ankney,C.D. and Macinnes,C.D.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 28, pp 8-8

Ankney-CD, "Nutrient Reserves and Clutch Size - A Citation-Classic Commentary on Nutrient Reserves and Reproductive-Performance of Female Lesser Snow Geese by Ankney,C.D. and Macinnes,C.D.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 28, pp 8-8

Antle-JM Wagenet-RJ, "Why Scientists Should Talk to Economists", AGRONOMY JOURNAL 1995, Vol 87, Iss 6, pp 1033-1040

AP, Forgotten 1960s Quest for Planarian Learning,. a Biochemical Engram, and Celebrity", AMERICAN PSYCHOLOGIST 1996, Vol 51, Iss 6, pp 589-598

Araji-AA White-FC Guenthner-JF, "Spillovers and the Returns to Agricultural-Research for Potatoes", JOURNAL OF AGRICULTURAL AND RESOURCE ECONOMICS 1995, Vol 20, Iss 2, pp 263-276

Archibald-G Line-MB, "The Size and Growth of Serial Literature 1950-1987, in Terms of the Number of Articles per Serial", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 173-196

Aris-R, "Longitudinal Dispersion Due to Lateral Diffusion - A Citation-Classic Commentary on the Dispersion of a Solute in a Fluid Flowing Through a Tube by Aris,R.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 2, pp 8-8

Arispe-IE Bernstein-JF, "Linking Evaluation and Program-Development - The Case of Ahcpr-Supported Clinical-Practice Guidelines", EVALUATION & THE HEALTH PROFESSIONS 1996, Vol 19, Iss 3, pp 377-393

Armstrong-J, "Remain Calm - Its Only Peer-Review at Work", SEARCH,1993, Vol 24, Iss 4, pp 98-100

Armstrong-JS Arkes-HR Franke-RH Peterson-RA Armstrong-JS, "The Ombudsman - Management Folklore and Management Science - On Portfolio Planning, Escalation Bias, and Such", INTERFACES 1996, Vol 26, Iss 4, pp 25-55

Armstrong-JS Sperry-T, "The Ombudsman - Business School Prestige Research Versus Teaching", INTERFACES,1994, Vol 24, Iss 2, pp 13-22

Armstrong-MI Huz-S Evans-ME, "What Works for Whom - The Design and Evaluation of Childrens Mental-Health-Services", SOCIAL WORK RESEARCH & ABSTRACTS,1992, Vol 28, Iss 1, pp 35-41

Arndt-KA, "My Journal Is Smaller Than Your Journal", AMERICAN JOURNAL OF DERMATOPATHOLOGY,1994, Vol 16, Iss 3, pp 231-232

Arnzen-MA, "Cyber Citations", INTERNET WORLD 1996, Vol 7, Iss 9, pp 72-74

Arthurs-AM, "Canonicals, Saddles, and Bounds - A Citation-Classic Commentary on Complementary Variational-Principles by Arthurs,A.M.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 24, pp 8-8

Artus-HM, "Science Indicators Derived from Databases - The Case of the Social-Sciences", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 297-311

Arunachalam-S Singh-UN Sinha-R, "The Sleeping Dragon Wakes Up - A Scientometric Analysis of the Growth of Science and the Usage of Journals in China", CURRENT SCIENCE,1993, Vol 65, Iss 11, pp 809-822

Arunachalam-S Singh-UN, "Access to Information and the Scientific Output of India", JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH,1992, Vol 51, Iss 2, pp 99-119

Arunachalam-S Srinivasan-R Raman-V, "International Collaboration in Science - Participation by the Asian Giants", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 7-22

Arutyunov-VV Medvedeva-IE, "Citation of Scientific Literature

on Geology", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 1-ORGANIZATSIYA I METODIKA INFORMATSIONNOI RABOTY,1992, Iss 9, pp 24-30

Arvanitis-R Russell-JM Rosas-AM, "Experiences with the National Citation Reports Database for Measuring National Performance - The Case of Mexico", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 247-255

Ashoor-MS Chaudhry-AS, "Publication Patterns of Scientists Working in Saudi-Arabia", INTERNATIONAL INFORMATION & LIBRARY REVIEW,1993, Vol 25, Iss 1, pp 61-71

Astin-HS, "Citation-Classics - Womens and Mens Perceptions of Their Contributions to Science (Reprinted from the Outer Circle - Women in the Scientific Community ,1991)", CURRENT CONTENTS,1993, Vol 35, Iss AUG, pp 6-11

Aswad-DW, "Peer-Review", SCIENTIST,1994, Vol 8, Iss 14, pp 13-13

Atkinson-M, "Regulation of Science by Peer-Review", STUDIES IN HISTORY AND PHILOSOPHY OF SCIENCE,1994, Vol 25, Iss 2, pp 147-158

Atkinson-M Elguebaly-N, "Research Productivity Among PhD Faculty Members and Affiliates Responding to the Canadian-Association-of-Professors-of-Psychiatry-and-Canadian-Psychiatric-Association-Survey", CANADIAN JOURNAL OF PSYCHIATRY-REVUE CANADIENNE DE PSYCHIATRIE 1996, Vol 41, Iss 8, pp 509-512

Attala-JM Warmington-M, "Clients Evaluation of Health-Care Services in a Battered Womens Shelter", PUBLIC HEALTH NURSING 1996, Vol 13, Iss 4, pp 269-275

Atz-JW, "Fish Endocrinology Reviewed - A Citation-Classic Commentary on the Physiology of the Pituitary-Gland of Fishes by Pickford,G.E., Atz,J.W.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 42, pp 10-10

Audet-AM Scott-HD, "The Oversight of Medical-Care - A Proposal for Reform", ANNALS OF INTERNAL MEDICINE,1994, Vol 120, Iss 5, pp 423-431

Avdeev-AV Avdeeva-TV Poizner-BN, "A Scientometric Investigation of the Development of Quantum-Electronics Trends During 25 Years", KVANTOVAYA ELEKTRONIKA,1991, Vol 18, Iss 3, pp 394-396

Averch-HA, "Economic Approaches to the Evaluation of Research", EVALUATION REVIEW,1994, Vol 18, Iss 1, pp 77-88

Aversa-E, "Research on Research - Customized Citation Analysis for Government, Industrial, and Academic Clients", CURRENT CONTENTS,1992, Vol 23, Iss JUN, pp 7-13

Axelrod-J, "Microsomal-Enzymes That Metabolize Drugs - A Citation-Classic Commentary on an Enzyme for the Deamination of Sympathomimetic Amines - Properties and Distribution - The Enzymatic Deamination of Amphetamine (Benzedrine) - Enzymatic Demethylation of Sympathomimetic Amines - The Enzymatic Demethylation of Ephedrine by Axelrod,J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 18, pp 11-11

Axelrod-R, "How to Promote Cooperation - A Citation-Classic Commentary on the Evolution of Cooperation by Axelrod,R., Hamilton,W.D. and on the Evolution of Cooperation by Axelrod,R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 44, pp 10-10

Axelrod-RzzTitle: How to Promote Cooperation - A Citation-Classic Commentary on the Evolution of Cooperation by

Axelrod,R., and Hamilton,W.D. and the Evolution of Cooperation by Axelrod,R. ", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 44, pp 10-10

Ayala-FJ, "On the Scientific Method, Its Practice and Pitfalls", HISTORY AND PHILOSOPHY OF THE LIFE SCIENCES,1994, Vol 16, Iss 2, pp 205-240

Azbel-M, "Could Columbus Have Passed Peer-Review", PHYSICS TODAY,1993, Vol 46, Iss 6, pp 13+

Bach-FH, "The Importance of MLC - A Citation-Classic Commentary on Lymphocyte Interaction - A Potential HistocompatibilityTest Invitro by Bach,F., and Hirschhorn,K.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 14, pp 10-10

Bach-L Condemolist-N Ledoux-MJ Matt-M Schaeffer-V, "Evaluation of the Economic-Effects of Brite-Euram Programs on the European Industry", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 325-349

Bader-GE Bloom-AE, "How to Do Peer-Review", TRAINING & DEVELOPMENT,1992, Vol 46, Iss 6, pp 61-

Badrinath-SG Bolster-PJ, "The Role of Market Forces in EPA Enforcement Activity", JOURNAL OF REGULATORY ECONOMICS 1996, Vol 10, Iss 2, pp 165-181

Bailar-JC, "Reliability, Fairness, Objectivity, and Other Inappropriate Goals in Peer-Review", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 137-137

Bailey-PS, "A Background for Ozonation Research - A Citation-Classic Commentary on the Reactions of Ozone with Organic-Compounds by Bailey,P.S.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 8, pp 8-8

Baimbridge-M Simpson-C, "Rewards to Academia - The Remuneration of Vice Chancellors and Principals", APPLIED ECONOMICS 1996, Vol 28, Iss 6, pp 631-639

Baird-LM Oppenheim-C, "Do Citations Matter", JOURNAL OF INFORMATION SCIENCE,1994, Vol 20, Iss 1, pp 2-15

Baker-DR, "Online Bibliometric Analysis for Researchers and Educators", JOURNAL OF SOCIAL WORK EDUCATION,1991, Vol 27, Iss 1, pp 41-47

Baker-DR, "Problems of Citation Analysis - Reply", SOCIAL WORK RESEARCH & ABSTRACTS,1992, Vol 28, Iss 4, pp 4-5

Baker-SJ, "Use of Performance Indicators for General-Practice", BRITISH MEDICAL JOURNAL 1996, Vol 312, Iss 7022, pp 58-58

Baklien-B, "Evaluation Research in Norway", TIDSSKRIFT FOR SAMFUNNSFORSKNING,1993, Vol 34, Iss 3, pp 261-274

Balaban-AT, "Can the Assignment of University Chairs Be Automated", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 121-122

Baldi-S, "Prestige Determinants of First Academic Job for New Sociology PhDs 1985-1992", SOCIOLOGICAL QUARTERLY 1995, Vol 36, Iss 4, pp 777-789

Baldwin-CD Goldblum-RM Rassin-DK Levine-HG, "Facilitating Faculty-Development and Research Through Critical-Review of Grant Proposals and Articles", ACADEMIC MEDICINE,1994, Vol 69, Iss 1, pp 62-64

Ball-R Wilkinson-R, "The Use and Abuse of Performance Indicators in UK Higher-Education", HIGHER EDUCATION,1994, Vol 27,

Iss 4, pp 417-427

Balla-M Knothe-B Lancaster-J Prager-S Beatson-J, "Group Peer-Review in Psychiatry - The Relationship to Quality Improvement and Quality Care", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY 1996, Vol 30, Iss 5, pp 653-659

Bandura-A, "Sociocognitive Theory of Human Adaptation - A Citation-Classic Commentary on Social-Learning Theory, by Bandura,A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 38, pp 10-10

Bandyopadhyay-SP Brown-LD Richardson-GD, "Analysts Use of Earnings Forecasts in Predicting Stock Returns - Forecast Horizon Effects", INTERNATIONAL JOURNAL OF FORECASTING 1995, Vol 11, Iss 3, pp 429-445

Banik-GM Tumolo-J, "Hypernavigation of the Chemical Literature", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 8-CINF

Banks-WA, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1410-1410

Barad-M, "Some Cultural/Geographical Styles in Quality Strategies and Quality Costs (Peoples-Republic-of-China Versus Australia)", INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS 1995, Vol 41, Iss 1-3, pp 81-92

Barak-Y Philpot-M Levy-R, "Citation Patterns in the International-Journal-of-Geriatric-Psychiatry - Cultural Ethnocentrism Revisited", INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY 1995, Vol 10, Iss 12, pp 1015-1018

Bard-AJ, "Towards Artificial Photosynthetic Systems - A Citation-Classic Commentary on Photoelectrochemistry and Heterogeneous Photocatalysis at Semiconductors by Bard,A.J.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 26, pp 8-8

Barenys-M Recasens-MA Camps-J Salassalvado-J, "Spanish Scientific Production Concerning Alimentation and Nutrition from 1987 to 1990", MEDICINA CLINICA,1992, Vol 99, Iss 1, pp 9-12

Barker-K, "Evaluating Research-and-Development Impacts - Methods and Practice, by B. Bozeman, J. Melkers", R & D MANAGEMENT,1994, Vol 24, Iss 4, pp 391-392

Barkley-RA Guevremont-DC Anastopoulos-AD Dupaul-GJ Shelton-TL, "Driving-Related Risks and Outcomes of Attention-Deficit Hyperactivity Disorder in Adolescents and Young-Adults - A 3-Year to 5-Year Follow-Up Survey", PEDIATRICS,1993, Vol 92, Iss 2, pp 212-218

Barnes-DE Bero-LA, "Industry-Funded Research and Conflict-of-Interest - An Analysis of Research Sponsored by the Tobacco Industry Through the Center-for-Indoor-Air-Research", JOURNAL OF HEALTH POLITICS POLICY AND LAW 1996, Vol 21, Iss 3, pp 515-542

Barnes-M, "Introducing New Stakeholders User and Researcher Interests in Evaluative Research - A Discussion of Methods Used to Evaluate the Birmingham-Community-Care-Special-Action-Project", POLICY AND POLITICS,1993, Vol 21, Iss 1, pp 47-58

Barnes-RV Lawton-L Briggs-D, "Clinical Benchmarking Improves Clinical Paths - Experience with Coronary-Artery Bypass-Grafting", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT,1994, Vol 20, Iss 5,

pp 267-276

Barnstable-CJ, "Monoclonal-Antibodies to Human Cell-Surface Antigens - A Citation-Classic Commentary on Production of Monoclonal-Antibodies to Group-A Erythrocytes, HLA and Other Human Cell-Surface Antigens New Tools for Genetic-Analysis by Barnstable,C.J., Bodmer,W.F., Brown,G., Galfre,G., Milstein,C., Williams,A.F. and Ziegler,A.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 16, pp 8-8

Baron-RS Vandello-JA Brunsman-B, "The Forgotten Variable in Conformity Research - Impact of Task Importance on Social-Influence", JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY 1996, Vol 71, Iss 5, pp 915-927

Barraclough-CA, "The Inherently Feminine Brain - A Citation-Classic Commentary on Evidence That the Hypothalamus Is Responsible for Androgen-Induced Sterility in the Female Rat by Barraclough,C.A., Gorski,R.A.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 38, pp 10-10

Barre-R, "Clustering Research Fields for Macro-Strategic Analysis -A Comparative Specialization Approach", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 95-112

Barre-R, "Correction", SCIENTOMETRICS,1992, Vol 23, Iss 2, pp 353-353

Barre-R, "Do Not Look for Scapegoats - Link Bibliometrics to Social-Sciences and Address Societal Needs", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 419-424

Barre-R, "Indicators of the Emerging European S-and-T Space - Results of the 1st International-Conference on European S-and-T Indicators", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 465-469

Barrelmeyer-U, "Why Classical Authors - A Citation Analysis of the Reception of Simmel,Georg", ZEITSCHRIFT FUR SOZIOLOGIE,1992, Vol 21, Iss 4, pp 296-306

Barrett-TJ Berger-BL Bradley-LA, "Performance Contracting - The Colorado Model Revisited", ADMINISTRATION AND POLICY IN MENTAL HEALTH,1992, Vol 20, Iss 2, pp 75-85

Barro-RJ, "Ricardian Equivalence - A Citation-Classic Commentary on Are Government Bonds Net Wealth by Barro,R.J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 2, pp 8-8

Barro-RJ, "The New Classical Approach to Macroeconomics - A Citation-Classic Commentary on Rational-Expectations and the Role of Monetary-Policy by Barro,R.J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 26, pp 8-8

Barron-CL, "Qualitative Evaluation and Research Methods, 2nd Edition, by M.Q. Patton", BRITISH JOURNAL OF PSYCHOLOGY,1991, Vol 82, Iss MAY, pp 237-238

Barron-L Bransford-J Campbell-O Ferron-B Goin-L Goldman-E Goldman-S Hasselbring-T Heath-A Kinzer-C Pellegrino-J Rewey-K Sherwood-R Vye-N Warren-S Williams-S, "The Jasper Experiment - An Exploration of Issues in Learning and Instructional-Design", ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT,1992, Vol 40, Iss 1, pp 65-80

Barrouillet-P, "Transitive Inferences from Set-Inclusion Relations and Working-Memory", JOURNAL OF EXPERIMENTAL

PSYCHOLOGY-LEARNING MEMORY AND COGNITION 1996, Vol 22, Iss 6, pp 1408-1422

Barten-AP, "The Vicissitudes of a Research-Project - A Citation-Classic Commentary on Maximum-Likelihood-Estimation of a Complete System of Demand Equations by Barten,A.P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 40, pp 8-8

Basenengquist-K, "Handbook of Adolescent Sexuality and Pregnancy - Research and Evaluation Instruments, by J.J. Card", JOURNAL OF MARRIAGE AND THE FAMILY,1994, Vol 56, Iss 2, pp 521-522

Baskent-EZ Jordan-GA, "Designing Forest Management to Control Spatial Structure of Landscapes", LANDSCAPE AND URBAN PLANNING 1996, Vol 34, Iss 1, pp 55-74

Basler-HD Schieferbein-J, "Scientific Productivity in Medical Psychology", PSYCHOLOGISCHE RUNDSCHAU,1995, Vol 46, Iss 1, pp 36-41

Batchelor-GK, "An Introduction to Fluid-Dynamics - A Citation-Classic Commentary on an Introduction to Fluid-Dynamics by Batchelor,G.K.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 40, pp 8-8

Bateman-RM, "Citation Counting", SCIENCE,1991, Vol 252, Iss 5013, pp 1599-1599

Battersby-AR, "Probing Natures Pathways to Alkaloids - A Citation-Classic Commentary on the Biosynthesis of Alkaloids by Battersby,A.R.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 42, pp 10-10

Bauer-TN Hammer-LB, "Help Received During the Journal Article Writing Process - The Outcomes of Quality and Quantity", JOURNAL OF SOCIAL BEHAVIOR AND PERSONALITY 1996, Vol 11, Iss 2, pp 213-224

Bauin-S Michelet-B Schweighoffer-MG Vermeulin-P, "Using Bibliometrics in Strategic Analysis - Understanding Chemical-Reactions at the CNRS", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 113-137

Baum-L, "Specialization and Authority Acceptance - The Supreme-Court and Lower Federal-Courts", POLITICAL RESEARCH QUARTERLY,1994, Vol 47, Iss 3, pp 693-703

Baur-WH, "Predicting Bond Lengths from Bond Strengths - A Citation-Classic Commentary on Bond Length Variation and Distorted Coordination Polyhedra in Inorganic Crystals by Baur,W.H.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 48, pp 8-8

Bawden-D, "Teaching Information Skills - A Review of the Research and Its Impact on Education, by R. Rogers", INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT,1994, Vol 14, Iss 4, pp 310-311

Baxby-D, "Should Smallpox Virus Be Destroyed - The Relevance of the Origins of Vaccinia Virus", SOCIAL HISTORY OF MEDICINE 1996, Vol 9, Iss 1, pp 117-119

Baxter-GP Elder-AD, "Knowledge-Based Cognition and Performance Assessment in the Science Classroom", EDUCATIONAL PSYCHOLOGIST 1996, Vol 31, Iss 2, pp 133-140

Bazan-NG, "Neural Stimulation or Onset of Cerebral-Ischemia Activates Phospholipase-A2 - A Citation-Classic Commentary on Effects of Ischemia and Electroconvulsive Shock on Free Fatty-Acid Pool in the Brain, by Bazan,N.G.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss

30, pp 10-10

Beatson-J Rushford-N Halasz-G Lancaster-J Prager-S, "Group Peer-Review - A Questionnaire-Based Survey", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY 1996, Vol 30, Iss 5, pp 643-652

Beatson-JA, "The Psychiatrist and Peer-Review - A Psychodynamic Perspective", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY,1993, Vol 27, Iss 2, pp 319-323

Beatson-JA Lancaster-JE, "Peer-Review of Psychotherapeutic Treatments in Psychiatry - A Review of the Literature", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY,1993, Vol 27, Iss 2, pp 311-318

Beaven-MA, "Histamine Revisited - A Citation-Classic Commentary on Modification of the Enzymatic Isotopic Assay of Histamine and Its Application to Measurement of Histamine in Tissues, Serum and Urine by Beaven,M.A., Jacobsen,S., Horakova,Z.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 24, pp 8-8

Bechtereva-NP, "Citation in Science - A Reply", INTERNATIONAL JOURNAL OF PSYCHOPHYSIOLOGY,1993, Vol 15, Iss 1, pp 3-5

Beck-MT, "Guardians of Science - Fairness and Reliability of Peer-Review System, by H.D. Daniel", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 91-92

Beck-MT, "Scientometric Evaluation of the Scientific Performance at the Faculty of Natural-Sciences, Kossuth Lajos University, Debrecen, Hungary", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 37-54

Beck-RJ Janikowski-TP Stebnicki-MA, "Doctoral Dissertation Research Is Rehabilitation - 1992-1993", REHABILITATION COUNSELING BULLETIN 1996, Vol 39, Iss 3, pp 165-188

Bedford-KW, "The Journal of Great-Lakes Research - An Evaluation upon the 20th Volume", JOURNAL OF GREAT LAKES RESEARCH,1994, Vol 20, Iss 1, pp 317-326

Beecham-L, "Do Performance Indicators Have a Role in Health Promotion", BRITISH MEDICAL JOURNAL 1996, Vol 313, Iss 7062, pp 947-947

Beecham-L, "NHS Introduces New Performance Indicators for ,1994-5", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6964, pp 1306-1306

Beed-C Beed-C, "Measuring the Quality of Academic Journals - The Case of Economics", JOURNAL OF POST KEYNESIAN ECONOMICS 1996, Vol 18, Iss 3, pp 369-396

Behrens-H, "Data Import and Validation in the Inorganic Crystal-Structure Database", JOURNAL OF RESEARCH OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY 1996, Vol 101, Iss 3, pp 365-373

Bekavac-A Petrak-J Buneta-Z, "Citation Behavior and Place of Publication in the Authors from the Scientific Periphery - A Matter of Quality", INFORMATION PROCESSING & MANAGEMENT,1994, Vol 30, Iss 1, pp 33-42

Bell-JF, "Science Performance and Uptake by 15-Year-Old Pupils in Northern-Ireland", EDUCATIONAL RESEARCH,1991, Vol 33, Iss 2, pp 93-102

Benfield-JR, "The Anatomy of Peer-Review", JOURNAL OF THORACIC AND CARDIOVASCULAR SURGERY,1991, Vol 101, Iss 2, pp 190-195

Bennett-JV, "When Nature Prefers a Curve - A Citation-Classic Commentary on Simplified Accurate Method for Assay of Clinical

Specimens by Bennett,J.V., Brodie,J.L., Benner,E.J. and Kirby,W.M.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 36, pp 8-8

Benning-SP Speer-SC, "Incorrect Citations - A Comparison of Library Literature with Medical Literature", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol 81, Iss 1, pp 56-58

Benowitz-S, "Scientific Enterprise at Critical Juncture, Says Panelists, Researchers", SCIENTIST 1996, Vol 10, Iss 20, pp 3-6

Bensman-SJ, "The Structure of the Library Market for Scientific Journals - The Case of Chemistry", LIBRARY RESOURCES & TECHNICAL SERVICES 1996, Vol 40, Iss 2, pp 145+

Benson-JS, "Optimum Science for Product Review - An Industry Perspective", FOOD AND DRUG LAW JOURNAL,1994, Vol 49, Iss 2, pp 415-419

Bentler-RA Pavlovic-CV, "Addendum to Transfer-Functions and Correction Factors Used in Hearing-Aid Evaluation and Research", EAR AND HEARING,1992, Vol 13, Iss 4, pp 284-286

Bentley-R Blackburn-R, "Changes in Academic Research Performance over Time - A Study of Institutional Accumulative Advantage", RESEARCH IN HIGHER EDUCATION1990, Vol 31, Iss 4, pp 327-353

Berezin-AA, "Peer-Review and Anonymity", SCIENTIST,1994, Vol 8, Iss 19, pp 13-13

Berezkin-VG Koshevnik-MA, "Scientometric Analysis of the Current State in Chromatography", JOURNAL OF ANALYTICAL CHEMISTRY OF THE USSR,1992, Vol 47, Iss 1, pp 55-61

Berg-J Wagnerdobler-R, "A Multidimensional-Analysis of Scientific Dynamics .1. Case-Studies of Mathematical Logic in the 20th-Century", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 321-346

Berg-M, "Womens Consumption and the Industrial Classes of 18th-Century England", JOURNAL OF SOCIAL HISTORY 1996, Vol 30, Iss 2, pp 415+

Berger-E Springerkremser-M, "Ekstein,Rudolf Contributions to Psychotherapy and Child-Psychiatry", WIENER KLINISCHE WOCHENSCHRIFT 1996, Vol 108, Iss 13, pp 407-413

Berger-J, "IgA Nephropathy - A Citation-Classic Commentary on IgA Glomerular Deposits in Renal-Disease by Berger,J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 42, pp 10-10

Berger-RL, "Ethics in Scientific Communication - Study of a Problem Case", JOURNAL OF MEDICAL ETHICS,1994, Vol 20, Iss 4, pp 207-211

Bergman-R, "Report Cards Alone Wont Make the Grade, Says Peer-Review Group", HOSPITALS & HEALTH NETWORKS,1994, Vol 68, Iss 13, pp 60-60

Bergvallkareborn-B Grahn-A, "Expanding the Framework for Monitor and Control in Soft Systems Methodology", SYSTEMS PRACTICE 1996, Vol 9, Iss 5, pp 469-495

Beritic-T, "Medical Reviews and the Importance of Being a Peer in Science", ISRAEL JOURNAL OF MEDICAL SCIENCES 1996, Vol 32, Iss 7, pp 573-575

Berman-E Bound-J Griliches-Z, "Changes in the Demand for Skilled Labor Within United-States Manufacturing - Evidence from the

Annual Survey of Manufactures", QUARTERLY JOURNAL OF ECONOMICS,1994, Vol 109, Iss 2, pp 367-397

Berman-Y Eaglstein-AS, "The Knowledge-Base of Social-Work - A Citation Analysis", ASLIB PROCEEDINGS,1994, Vol 46, Iss 9, pp 225-230

Berndt-ER Griliches-Z Rosett-JG, "Auditing the Producer Price-Index - Microevidence from Prescription Pharmaceutical Preparations", JOURNAL OF BUSINESS & ECONOMIC STATISTICS,1993, Vol 11, Iss 3, pp 251-264

Berry-BJL, "Peer-Review - Is It Working", URBAN GEOGRAPHY 1995, Vol 16, Iss 8, pp 655-656

Berry-TD Gilmore-MR Geller-ES, "An Individual-Subject Approach to the Study of Community-Based Interventions", ENVIRONMENT AND BEHAVIOR,1994, Vol 26, Iss 4, pp 451-476

Bettman-JR Johnson-EJ Payne-JW, "A Perspective on Using Computers to Monitor Information Acquisition", ADVANCES IN CONSUMER RESEARCH 1995, Vol 22, pp 49-51

Bettman-JW, "Antitrust and Peer-Review", SURVEY OF OPHTHALMOLOGY,1991, Vol 35, Iss 5, pp 386-388

Bevilacqua-JJ Morris-JA Pumariega-AJ, "State Services Research Capacity - Building a State Infrastructure for Mental-Health-Services Research", COMMUNITY MENTAL HEALTH JOURNAL 1996, Vol 32, Iss 6, pp 519-533

Beynon-J, "The States Role in Financing Agricultural-Research", FOOD POLICY 1995, Vol 20, Iss 6, pp 545-550

Bhushan-B Lal-B, "Indian Science-Citation-Index - A Strategy", PROGRAM-AUTOMATED LIBRARY AND INFORMATION SYSTEMS,1991, Vol 25, Iss 1, pp 59-67

Bialik-D Dilts-DA Samavati-H, "Higher-Education - Fertile Ground for ADR", DISPUTE RESOLUTION JOURNAL,1994, Vol 49, Iss 1, pp 61-66

Bickell-NA Zdeb-MS Applegate-MS Roohan-PJ Siu-AL, "Effect of External Peer-Review on Cesarean Delivery Rates - A Statewide Program", OBSTETRICS AND GYNECOLOGY 1996, Vol 87, Iss 5, pp 664-667

Biddle-J, "A Citation Analysis of the Sources and Extent of Mitchell,Wesley Reputation", HISTORY OF POLITICAL ECONOMY 1996, Vol 28, Iss 2, pp 137-169

Bidlingmeyer-BA Tarvin-TA, "Improved Amino-Acid-Analysis - A Citation-Classic Commentary on Rapid Analysis of Amino-Acids Using Precolumn Derivatization by Bidlingmeyer,B.A.,Cohen,S.A., Tarvin,T.L.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 50, pp 8-8

Bieber-JP Blackburn-RT, "Faculty Research Productivity 1972-1988 - Development and Application of Constant Units of Measure", RESEARCH IN HIGHER EDUCATION,1993, Vol 34, Iss 5, pp 551-567

Biebuyck-JF, "Concerning the Ethics and Accuracy of Scientific Citations", ANESTHESIOLOGY,1992, Vol 77, Iss 1, pp 1-2

Biebuyck-JF, "On the Importance of Inaccurate Bibliographic Citations - Reply", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 615-615

Bierman-L, "The Dynamics of State Constitutional Decision-Making - Judicial Behavior at the New-York-Court-of-Appeals", TEMPLE LAW REVIEW 1995, Vol 68, Iss 3, pp 1403-1456

Biggs-M, "The Impact of Peer-Review on Intellectual Freedom", LIBRARY TRENDS1990, Vol 39, Iss 1-2, pp 145-167

Billig-M, "The Base-Line of Intergroup Prejudice - A Citation-Classic Commentary on Social Categorization and Intergroup Behavior by Tajfel,H., Billig,M.G., Bundy,R.P., and Flament,C.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 4, pp 8-8

Bingham-C Coleman-R, "Enter the Web - An Experiment in Electronic Research Peer-Review", MEDICAL JOURNAL OF AUSTRALIA 1996, Vol 164, Iss 1, pp 8-9

BIOLOGICALS, International-Symposium on Pertussis Evaluation and Research on Acellular Pertussis Vaccines - National-Institute-of-Health in Tokyo and International-Association-of-Biological-Standardization - 14-15 September 1990 at Shizuoka, Japan", BIOLOGICALS,1991, Vol 19, Iss 2, pp 145-149

Bizzigotti-GO, "More on Peer-Review", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 16, pp 2-2

Bjorklund-A, "Evaluations of Labor-Market Policy in Sweden", INTERNATIONAL JOURNAL OF MANPOWER,1994, Vol 15, Iss 5, pp 16-31

Bjorkman-A, "Solvent-Extraction of Natural Lignin - A Citation-Classic Commentary on Studies on Finely Divided Wood .1. Extraction of Lignin with Neural Solvents by Bjorkman,A.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 32, pp 8-8

Bjorkmans-A, "Studies on Finely Divided Wood .1. Extraction of Lignin with Neutral Solvents (Reprinted from Svensk Papperstidning, Vol 59, Pg 477-485, 1956) Is a Citation-Classic", SVENSK PAPPERSTIDNING-NORDISK CELLULOSA,1992, Vol 95, Iss 12, pp 38+

Black-N, "The Relationship Between Evaluative Research and Audit", JOURNAL OF PUBLIC HEALTH MEDICINE,1992, Vol 14, Iss 4, pp 361-366

Blackburn-RT Bentley-RJ, "Faculty Research Productivity - Some Moderators of Associated Stressors", RESEARCH IN HIGHER EDUCATION,1993, Vol 34, Iss 6, pp 725-745

Blair-C Brown-JR Baxter-LA, "Disciplining the Feminine", QUARTERLY JOURNAL OF SPEECH,1994, Vol 80, Iss 4, pp 383-409

Blair-RS Harper-DW, "When Is Ethical Review of Research Protocols Necessary - A Proposed Classification-System for Evaluating Canadian Hospital-Based Research", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS 1995, Vol 27, Iss 2, pp 19-26

Bland-CJ Ruffin-MT, "Characteristics of a Productive Research Environment - Literature-Review", ACADEMIC MEDICINE,1992, Vol 67, Iss 6, pp 385-397

Bland-JM Altman-DG, "Comparing Methods of Clinical Measurement - A Citation-Classic Commentary on Statistical-Methods for Assessing Agreement Between 2 Methods of Clinical Measurement by Bland,J.M., and Altman,D.G.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 40, pp 8-8

Blasco-PG, "Socioeconomic Indicators on Research-and-Development in Spain", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 79-93

Blashfield-RK Wells-L, "Computerized Searches of the 1985 Personality-Disorder Literature", JOURNAL OF PERSONALITY DISORDERS

1996, Vol 10, Iss 3, pp 282-295

Bleaney-B, "Electron-Paramagnetic Resonance - A Citation-Classic Commentary on Electron-Paramagnetic Resonance of Transition Ions by Abragam,A. and Bleaney,B.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 28, pp 8-8

Bliss-NJ, "International Librarianship - A Bibliometric Analysis of the Field", INTERNATIONAL INFORMATION & LIBRARY REVIEW,1993, Vol 25, Iss 2, pp 93-107

Bloch-KJ, "Sjogren Connections - A Citation-Classic Commentary on Sjogrens-Syndrome - A Clinical, Pathological, and Serological Study of 62 Cases by Bloch,K.J., Buchanan,W.W., Wohl,M.J., and Bunim,J.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 40, pp 8-8

Bloembergen-N, "Light Waves Interact - A Citation-Classic Commentary on Interactions Between Light Waves in a Nonlinear Dielectric by Armstrong,J.A., Bloembergen,N., Ducuing,J. and Pershan,P.S.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 6, pp 10-10

Blume-SS, "Peerless Science - Peer-Review and United-States Science Policy, by D.E. Chubin, E.J. Hackett", SCIENCE,1991, Vol 251, Iss 4990, pp 211-213

Bobe-B, "Trends in the Use of Research-and-Development Output Indicators in EC Program-Evaluation", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 263-282

Boden-LI, "Policy Evaluation - Better Living Through Research", AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 1996, Vol 29, Iss 4, pp 346-352

Boden-M, "Peer-Review", NEW SCIENTIST,1991, Vol 129, Iss 1755, pp 3-3

Boekhorst-PT, "Measuring Quality - The IFLA Guidelines for Performance-Measurement in Academic-Libraries", IFLA JOURNAL-INTERNATIONAL FEDERATION OF LIBRARY ASSOCIATIONS 1995, Vol 21, Iss 4, pp 278+

Boivin-MJ Giordani-B Ndanga-K Maky-MM Manzeki-KM Ngunu-N, "Economic-Advantage and the Cognitive-Ability of Rural Children in Zaire", JOURNAL OF PSYCHOLOGY 1996, Vol 130, Iss 1, pp 95-107

Boles-JB, "Why Editing Matters", SOCIAL SCIENCE QUARTERLY 1996, Vol 77, Iss 1, pp 198-203

Bollini-P Reich-MR, "The Italian Fight Against World Hunger - A Critical Analysis of Italian Aid for Development in the 1980s", SOCIAL SCIENCE & MEDICINE,1994, Vol 39, Iss 5, pp 607-620

Bond-GC, "An Overview of Catalysis by Metals - A Citation-Classic Commentary on Catalysis by Metals by Bond,G.C.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 22, pp 8-8

Bonheim-H, "The Reception of Polish Philology Abroad", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 243-253

Bonitz-M, "International-Conference on Bibliometrics, Informetrics and Scientometric .4.", NACHRICHTEN FUR DOKUMENTATION,1994, Vol 45, Iss 1, pp 48-49

Bonitz-M, "Promoting Scientometrics by International Schools", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 451-453

Bonitz-M, "Schubert,Andras Wins the ,1993

Derek-John-Desollaprice-Award", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 233-235

Bonitz-M, "Scientometrics in the Context of the Solla-Price-Medal Winners 1984 to ,1993", NACHRICHTEN FUR DOKUMENTATION,1994, Vol 45, Iss 2, pp 105-111

Bonitz-M, "The Impact of Behavioral Principles on the Design of the System of Scientific Communication", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 107-111

Bonitz-M, "The Multidimensional Space of Scientometrics - Price,Derek,John,Desolla Awards 1984-,1993", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 3-14

Bonitz-M, "The Challenge of Scientometrics - The Development, Measurement and Self-Organization of Scientific Communications, by L. Leydesdorff", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 271-272

Bonitz-M, "Untitled", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 123-123

Bonitz-M Bruckner-E Scharnhorst-A, "Publication Structures - Comparison Between Countries", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1992, Vol 17, Iss 4, pp 17-20

Bonitz-M Bruckner-E Scharnhorst-A, "The Science Strategy Index", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 37-50

Bonzi-S, "Senior Faculty Perceptions of Research Productivity", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1992, Vol 29, pp 206-211

Bonzi-S, "Trends in Research Productivity Among Senior Faculty", INFORMATION PROCESSING & MANAGEMENT,1992, Vol 28, Iss 1, pp 111-120

Bonzi-S Snyder-HW, "Motivations for Citation - A Comparison of Self Citation and Citation to Others", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 245-254

Bookstein-A, "Scientometrics - New Opportunities", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 455-460

Bookstein-A, "Towards a Multidisciplinary Bradford Law", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 353-361

Boone-C Debrabander-B Vanwitteloostuijn-A, "CEO Locus of Control and Small Firm Performance - An Integrative Framework and Empirical-Test", JOURNAL OF MANAGEMENT STUDIES 1996, Vol 33, Iss 5, pp 667-699

Boots-B, "Referees as Gatekeepers - Some Evidence from Geographical Journals", AREA 1996, Vol 28, Iss 2, pp 177-185

Bor-R Miller-R Goldman-E, "HIV AIDS and the Family - A Review of Research in the 1st Decade", JOURNAL OF FAMILY THERAPY,1993, Vol 15, Iss 2, pp 187-204

Bordons-M Barrigon-S, "Bibliometric Analysis of Publications of Spanish Pharmacologists in the Sci (1984-89) .2. Contribution to Subfields Other Than Pharmacology and Pharmacy (ISI)", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 425-446

Bordons-M Barrigon-S Mendez-A, "Spanish Investigation in International Pharmacy and Pharmacology Journals from 1980-1989", MEDICINA CLINICA 1996, Vol 106, Iss 2, pp 51-59

Bordons-M Garciajover-F Barrigon-S, "Bibliometric Analysis of Publications of Spanish Pharmacologists in the Sci (1984-89) .1. Contribution to the Pharmacology and Pharmacy Subfield (ISI)", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 163-177

Bordons-M Gomez-I Fernandez-MT Zulueta-MA Mendez-A, "Local, Domestic and International Scientific Collaboration in Biomedical-Research", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 279-295

Borgman-CL Rice-RE, "The Convergence of Information-Science and Communication - A Bibliometric Analysis", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 6, pp 397-411

Borko-H, "Guardians of Science - Fairness and Reliability of the Peer-Review Process, by H.D. Daniel", KNOWLEDGE ORGANIZATION,1994, Vol 21, Iss 2, pp 108-108

Borkowski-A Berman-JJ Moore-GW, "Research by Pathologists Not Funded by External Grant Agencies - A Success Story", MODERN PATHOLOGY,1992, Vol 5, Iss 5, pp 577-579

Bornstein-RF, "The Predictive-Validity of Peer-Review - A Neglected Issue", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 138-138

Bornstein-RF, "The Gatekeepers of Psychology - Evaluation of Peer-Review by Case-History, by E.R. Harcum, E.F. Rosen", JOURNAL OF NERVOUS AND MENTAL DISEASE,1994, Vol 182, Iss 8, pp 483-484

Borokhovich-KA Bricker-RJ Simkins-BJ, "Journal Communication and Influence in Financial Research", JOURNAL OF FINANCE,1994, Vol 49, Iss 2, pp 713-725

Borst-HG, "The 1st of 300 - A Citation-Classic Commentary on the Influence of Pulmonary Arterial and Left Atrial Pressures on Pulmonary Vascular-Resistance by Borst,H.G., Mcgregor,M., Whittenberger,J.L., andBerglund,E.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 8, pp 8-8

Boston-PF Dursun-SM Reveley-MA, "Cholesterol and Mental Disorder", BRITISH JOURNAL OF PSYCHIATRY 1996, Vol 169, Iss 6, pp 682-689

Bott-DM Hargens-LL, "Are Sociologists Publications Uncited - Citation Rates of Journal Articles, Chapters and Books (Reprinted from the American Sociologist, Summer, Pg 147-158, ,1991)", CURRENT CONTENTS,1993, Vol 5, Iss FEB, pp 5-12

Bott-DM Hargens-LL, "Are Sociologists Publications Uncited - Citation Rates of Journal Articles, Chapters and Books (Reprinted from the American Sociologist, Summer, Pg 147-158, ,1991)", CURRENT CONTENTS,1993, Vol 5, Iss FEB, pp 5-12

Bourke-P Butler-L, "Standards Issues in a National Bibliometric Database - The Australian Case", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 199-207

Bowden-SC Smith-LC, "What Does the Austin Maze Measure", AUSTRALIAN PSYCHOLOGIST,1994, Vol 29, Iss 1, pp 34-37

Boyum-A, "Methods of Separation - A Citation-Classic Commentary on Separation of Blood Leukocytes, Granulocytes and Lymphocytes and Isolation of Lymphocytes, Granulocytes and Macrophages by Boyum,A.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 28, pp 8-8

Braam-RR Moed-HF Vanraan-AFJ, "Mapping of Science by Combined Cocitation and Word Analysis .1. Structural Aspects", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 4, pp 233-251

Braam-RR Moed-HF Vanraan-AFJ, "Mapping of Science by Combined Cocitation and Word Analysis .2. Dynamic Aspects", JOURNAL OF THE

AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 4, pp 252-266

Bradbury-J, "Interactive Peer-Review Trial Starts in Australia", LANCET 1996, Vol 347, Iss 9006, pp 957-957

Braddom-CL, "A Framework for Writing and or Evaluating Research Papers", AMERICAN JOURNAL OF PHYSICAL MEDICINE & REHABILITATION,1991, Vol 70, Iss 1, pp S169-S171

Braddom-CL, "A Framework for Writing and or Evaluating Research Papers", AMERICAN JOURNAL OF PHYSICAL MEDICINE & REHABILITATION1990, Vol 69, Iss 6, pp 333-335

Bradley-SJ Willett-P Wood-FE, "A Publication and Citation Analysis of the Department of Information Studies, University-of-Sheffield, 1980-1990", JOURNAL OF INFORMATION SCIENCE,1992, Vol 18, Iss 3, pp 225-232

Bradshaw-RH Bubier-NE, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 183-183

Bragg-DG Hendee-WR, "Support for Biomedical-Research and Its Impact on Radiology", RADIOLOGY,1994, Vol 193, Iss 3, pp 599-603

Brahams-D, "Peer-Review of a London Hospital", LANCET,1993, Vol 342, Iss 8882, pp 1293-1293

Brand-R Vanhemel-OJS Elferinkstinkens-PM Verloovevanhorick-SP, "Comparing Mortality and Morbidity in Hospitals - Theory and Practice of Quality Assessment in Peer-Review", METHODS OF INFORMATION IN MEDICINE,1994, Vol 33, Iss 2, pp 196-204

Brattstrom-BH, "All Reptiles Are Not Alike - A Citation-Classic Commentary on Body Temperatures of Reptiles by Brattstrom,B.H.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 10, pp 11-11

Braun-T, "Foreword to the Moravcsik,Michael Memorial Issue", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 3-7

Braun-T, "Foreword", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 373-373

Braun-T, "The Citation Impact of the Journal of Radioanalytical and Nuclear Chemistry", JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY-ARTICLES,1992, Vol 163, Iss 1, pp 3-6

Braun-T Glanzel-W Schubert-A, "Scientometric Indicators Datafiles", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 137-150

Braun-T Glanzel-W Maczelka-H Schubert-A, "World Science in the Eighties - National Performances in Publication Output and Citation Impact, 1985-1989 Versus 1980-1984 .1. All Science Fields Combined, Physics, and Chemistry", SCIENTOMETRICS,1994, Vol 29, Iss 3, pp 299-334

Braun-T Glanzel-W Schubert-A, "The Bibliometric Assessment of UK Scientific Performance - Some Comments on Martin Reply", SCIENTOMETRICS,1991, Vol 20, Iss 2, pp 359-362

Braun-T Glanzel-W Maczelka-H Schubert-A, "World Science in the Eighties - National Performances in Publication Output and Citation Impact, 1985-1989 Versus 1980-1984 .2. Life Sciences, Engineering, and Mathematics", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 3-30

Braun-T Glanzel-W, "International Collaboration - Will It Be Keeping Alive East European Research", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 247-254

Braun-T Gomez-I Mendez-A Schubert-A, "International Coauthorship Patterns in Physics and Its Subfields, 1981-1985", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 181-200

Braun-T Maczelka-H Schubert-A, "Scientometric Indicators Datafiles - Summary Statistics and Trendlines of Major Geopolitical Regions, 1980-1989", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 211-217

Braun-T Nagydiosirozsa-S, "Habent-Sua-Fata-Libelli - Citation Impact of Books inAnalytical-Chemistry", ANALUSIS1990, Vol 18, Iss 10, pp 607-614

Braun-T Schubert-A, "The Landscape of National Performances in the Sciences, 1981-1985", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 9-17

Braun-T Schubert-A, "Indicators of Research Output in the Sciences from 5 Central-European Countries, 1990-1994", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 145-165

Braunwald-E, "The Stunned Myocardium - Prolonged, PostischemicVentricular Dysfunction - A Citation-Classic Commentary on the Stunned Myocardium - Prolonged, Postischemic Ventricular Dysfunction by Braunwald,E., Kloner,R.A.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 50, pp 8-8

Breathnach-C, "Endocrinology and the Psychiatrist", IRISH JOURNAL OF PSYCHOLOGICAL MEDICINE,1993, Vol 10, Iss 2, pp 110-113

Breimer-LH, "Age, Sex and Standards of Current Doctoral Theses by Swedish Medical Graduates", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 171-176

Breimer-LH Breimer-DD, "The Ced Le-DEC - Common-European-Doctorate, or Doctorate-Europeen-Commune or Dissertations on the Internet", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 347-353

Breimer-LH Mikhailidis-DP, "Towards a Doctoral Thesis Through Published Works", BIOMEDICINE & PHARMACOTHERAPY,1993, Vol 47, Iss 9, pp 403-407

Brems-C Johnson-ME Gallucci-P, "Publication Productivity of Clinical and Counseling Psychologists", JOURNAL OF CLINICAL PSYCHOLOGY 1996, Vol 52, Iss 6, pp 723-725

Brenner-BM, "3 Questions in Nephrology - A Citation-Classic Commentary on Dietary-Protein Intake and the Progressive Nature of Kidney-Disease - The Role of Hemodynamically Mediated Glomerular Injury in the Pathogenesis of Progressive Glomerular Sclerosis in Aging, Renal Ablation, and Intrinsic Renal-Disease by Brenner,BM, Meyer,Tw, Hostetter,Th", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 20, pp 8-8

Breshears-DD Whicker-FW Hakonson-TE, "Orchestrating Environmental-Research and Assessment for Remediation", ECOLOGICAL APPLICATIONS,1993, Vol 3, Iss 4, pp 590-594

Breslow-R, "Improving Peer-Review", CHEMICAL & ENGINEERING NEWS,1992, Vol 70, Iss 44, pp 2-2

Breslow-R, "Model Studies Clarify an Enzyme Mechanism - A Citation-Classic Commentary on the Mechanism of Thiamine Action .4. Evidence from Studies on Model Systems by Breslow,R.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 26, pp 8-8

Bretz-HJ Heekerens-HP Schmitz-B, "A Metaanalysis of the Effectiveness of Gestalt-Therapy", ZEITSCHRIFT FUR KLINISCHE

PSYCHOLOGIE PSYCHOPATHOLOGIE UND PSYCHOTHERAPIE,1994, Vol 42, Iss 3, pp 241-260

Breu-TM Raab-RL, "Efficiency and Perceived Quality of the Nations Top 25 National Universities and National Liberal-Arts Colleges- An Application of Data Envelopment Analysis to Higher-Education", SOCIO-ECONOMIC PLANNING SCIENCES,1994, Vol 28, Iss 1, pp 33-45

Breunung-L, "Analysis of Emigration in Science After 1933 - Sociological and Methodological Considerations in the Case of German Jurisprudence", ZEITSCHRIFT FUR SOZIOLOGIE 1996, Vol 25, Iss 5, pp 395+

Bridgstock-M, "The Quality of Single and Multiple Authored Papers - An Unresolved Problem", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 37-48

Briggs-S Gundry-L, "The Human Dimensions of Grievance Peer-Review", JOURNAL OF COLLECTIVE NEGOTIATIONS IN THE PUBLIC SECTOR,1994, Vol 23, Iss 2, pp 97-113

Brillson-L, "The Chemical-Dependence of Metal-Semiconductor Contacts -A Citation-Classic Commentary on the Structure and Properties of Metal-Semiconductor Interfaces by Brillson,L.J.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 42, pp 8-8

Bristow-MR, "Beta-Receptor Down-Regulation in the Failing Human Heart - A Citation-Classic Commentary on Decreased Catecholamine Sensitivity and Beta-Adrenergic-Receptor Density in Failing Human Hearts by Bristow,M.R., Ginsburg,R., Minobe,W., Cubicciotti,R.S., Sageman,W.S., Lurie,K., Billingham,M.E., Harrison,D.C., Stinson,E.B.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 44, pp 8-8

BRITISH JOURNAL OF HOSPITAL MEDICINE, Peer-Review of Almighty Judgments", BRITISH JOURNAL OF HOSPITAL MEDICINE,1993, Vol 50, Iss 1, pp 68-68

Britt-CL Kleck-G Bordua-DJ, "A Reassessment of the DC Gun Law - Some Cautionary Notes on the Use of Interrupted Time-Series Designs for Policy Impact Assessment", LAW & SOCIETY REVIEW 1996, Vol 30, Iss 2, pp 361-380

Brixey-SN Gallagher-BJ Mcfalls-JA Parmelee-LF, "Gestational and Neonatal Factors in the Etiology of Schizophrenia", JOURNAL OF CLINICAL PSYCHOLOGY,1993, Vol 49, Iss 3, pp 447-456

Broder-IE, "Professional Achievements and Gender Differences Among Academic Economists", ECONOMIC INQUIRY,1993, Vol 31, Iss 1, pp 116-127

Brody-EB, "A Difficult Balance - Editorial Peer-Review in Medicine, by S. Lock", JOURNAL OF NERVOUS AND MENTAL DISEASE,1991, Vol 179, Iss 6, pp 307-308

Brooks-CH, "Perceived Quality and Citation Rates of Health-Care Administration Journals", MEDICAL CARE,1994, Vol 32, Iss 6, pp 650-652

Brooks-CR, "Using Ethnography in the Evaluation of Drug Prevention and Intervention Programs", INTERNATIONAL JOURNAL OF THE ADDICTIONS,1994, Vol 29, Iss 6, pp 791-801

Brooks-JR, "Which Surgery Is Best for Pancreatic-Cancer - A Citation-Classic Commentary on Cancer of the Pancreas - Palliative

Operation, Whipple Procedure, or Total Pancreatectomy by Brooks,J.R. and Culebras,J.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 26, pp 8-8

Brooks-TA, "Dictionary of Bibliometrices, by V. Diodato", LIBRARY QUARTERLY 1996, Vol 66, Iss 1, pp 103-105

Brown-DF Dimilia-L, "Use of Robust Estimators of Missing Data in Evaluating Shiftwork Performance", WORK AND STRESS 1995, Vol 9, Iss 2-3, pp 360-367

Brown-EA, "Conforming the Government Research-and-Development Function with the Requirements of the Government Performance and Results Act - Planning the Unplannable - Measuring the Unmeasurable", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 445-470

Brown-LD, "Influential Accounting Articles, Individuals, PhD Granting Institutions and Faculties - A Citational Analysis", ACCOUNTING ORGANIZATIONS AND SOCIETY 1996, Vol 21, Iss 7-8, pp 723-754

Brown-LD, "Political Evolution of Federal Health-Care Regulation", HEALTH AFFAIRS,1992, Vol 11, Iss 4, pp 17-37

Brown-SD Lent-RW Ryan-NE Mcpartland-EB, "Self-Efficacy as an Intervening Mechanism Between Research Training Environments and Scholarly Productivity - A Theoretical and Methodological Extension", COUNSELING PSYCHOLOGIST 1996, Vol 24, Iss 3, pp 535-544

Brown-WH Odom-SL Holcombe-A, "Observational Assessment of Young Childrens Social-Behavior with Peers", EARLY CHILDHOOD RESEARCH QUARTERLY 1996, Vol 11, Iss 1, pp 19-40

Brun-R, "Cultivation of Human Pathogenic Blood Protozoa - A Citation-Classic Commentary on Cultivation and Invitro Cloning of Procyclic Culture Forms of Trypanosoma-Brucei in a Semi-Defined Medium by Brun,R., and Schonenberger,M.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 20, pp 8-8

Brunn-SD, "Quality Research Performance - Issues of Splitting, Cloning, Citing, Significance, and Judging", PROFESSIONAL GEOGRAPHER 1996, Vol 48, Iss 1, pp 103-105

Brunori-M, "The Fascination of Hemoglobin - A Roman Perspective - A Citation-Classic Commentary on Hemoglobin and Myoglobin in Their Reactions with Ligands - Frontiers of Biology, Volume 21 by Antonini,E., Brunori,M.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 22, pp 8-8

Brush-SG, "Dynamics of Theory Change in the Social-Sciences - Relative Deprivation and Collective Violence", JOURNAL OF CONFLICT RESOLUTION 1996, Vol 40, Iss 4, pp 523-545

Bryant-CJ Cole-HP Umberger-GH Kwak-E Ruch-WE Colligan-MJ, "Evaluative Research and Methods Development for the Assessment of Training Effectiveness in Occupational Respiratory Protection", SCANDINAVIAN JOURNAL OF WORK ENVIRONMENT & HEALTH,1992, Vol 18, Iss S2, pp 66-68

Buchanan-AL Goedeken-EA Herubel-JPVM, "Scholarly Communication Among Academic Librarians - An Analysis of 6 Acrl Proceedings", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN 1996, Vol 14, Iss 2, pp 1-15

Buchanan-AL Herubel-JPVM, "Comparing Materials Used in Philosophy and Political-Science Dissertations - A Technical Note",

BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1993, Vol 12, Iss 2, pp 63-70

Buchanan-AL Herubel-JPVM, "Profiling PhD Dissertation Bibliographies - Serials and Collection Development in Political-Science", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1994, Vol 13, Iss 1, pp 1-10

Buchanan-BB, "Light, Thioredoxin, and Chloroplasts - A Citation-Classic Commentary on Role of Light in the Regulation of Chloroplast Enzymes by Buchanan,B.B.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 20, pp 8-8

Buchholz-K, "Criteria for the Analysis of Scientific Quality", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 195-218

Budd-J, "Scholarly Communication and Bibliometrics, by C.L. Borgman", LIBRARY & INFORMATION SCIENCE RESEARCH,1991, Vol 13, Iss 2, pp 163-165

Budd-J Hurt-CD, "Superstring Theory - Information-Transfer in an Emerging Field", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 87-98

Budd-JM Seavey-CA, "Productivity of Us Library and Information-Science Faculty - The Hayes Study Revisited", LIBRARY QUARTERLY 1996, Vol 66, Iss 1, pp 1-20

Buescher-PA Taylor-KP Davis-MH Bowling-JM, "The Quality of the New Birth Certificate Data - A Validation-Study in North-Carolina", AMERICAN JOURNAL OF PUBLIC HEALTH,1993, Vol 83, Iss 8, pp 1163-1165

Buettner-GR, "Iron, Chelating-Agents, and Oxygen Radicals - A Citation-Classic Commentary on the Effect of Iron on the Distribution of Superoxide and Hydroxyl Radicals as Seen by Spin Trapping and on the Superoxide-Dismutase Assay by Buettner,G.R., Oberley,L.W. and Leuthauser,S.W.H.C. and Considerations in the Spin Trapping of Superoxide and Hydroxyl Radical in Aqueous Systems Using 5,5-Dimethyl-1-Pyrroline-1-Oxide by Buettner,G.R. and Oberley,L.W.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 2, pp 8-8

Buettner-GR, "Iron, Chelating-Agents, and Oxygen Radicals - A Citation-Classic Commentary on the Effect of Iron on the Distribution of Superoxide and Hydroxyl Radicals as Seen by Spin Trapping and on the Superoxide-Dismutase Assay by Buettner,G.R., Oberley,L.W. and Leuthauser,S.W.H.C. and Considerations in the Spin Trapping of Superoxide and Hydroxyl Radical in Aqueous Systems Using 5,5-Dimethyl-1-Pyrroline-1-Oxide by Buettner,G.R. and Oberley,L.W.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 2, pp 8-8

Bugental-JFT, "Context and Meaning in Writing Case-Reports", JOURNAL OF HUMANISTIC PSYCHOLOGY,1995, Vol 35, Iss 2, pp 99-102

Buhle-EL Goldwein-JW Benjamin-I, "Oncolink - A Multimedia Oncology Information Resource on the Internet", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Iss S, pp 103-107

Bulkley-GB, "The Intent of Peer-Reviewed Journals - Reply", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 633-634

Burdick-A, "Citation Patterns in the Health-Sciences - A Response", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1994, Vol 82, Iss 2, pp 224-224

Burdick-AJ Butler-A Sullivan-MG, "Citation Patterns in the Health-Sciences - Implications for Serials Monographic Fund Allocation", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol

81, Iss 1, pp 44-47

Burgoyne-JG, "The Competence Movement - Issues, Stakeholders and Prospects", PERSONNEL REVIEW,1993, Vol 22, Iss 6, pp 6-13

Burke-PG, "Electron-Scattering by Hydrogen-Atoms - A Citation-Classic Commentary on Elastic-Scattering of Low-Energy Electrons by Atomic-Hydrogen by Burke,P.G. and Schey,H.M. and the Low-Energy Scattering of Electrons and Positrons by Hydrogen-Atoms by Burke,P.G. and Smith,K.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 40, pp 8-8

Burnham-JF Shearer-BS Wall-JC, "Combining New Technologies for Effective Collection Development - A Bibliometric Study Using Cd-ROM and a Database-Management Program", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1992, Vol 80, Iss 2, pp 150-156

Burr-ML Fehily-AM Sweetnam-PM Elwood-PC, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 422-422

Burrell-Q, "Dictionary of Bibliometrics, by V. Diodato", JOURNAL OF DOCUMENTATION 1995, Vol 51, Iss 4, pp 448-450

Burrell-QL, "Scientostochastics", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 505-509

Burrell-QL, "The Bradford Distribution and the Gini Index", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 181-194

Burrell-QL, "The Gini Index and the Leimkuhler Curve for Bibliometric Processes", INFORMATION PROCESSING & MANAGEMENT,1992, Vol 28, Iss 1, pp 19-33

Burton-M Phimister-E, "The Ranking of Agricultural-Economics Journals", JOURNAL OF AGRICULTURAL ECONOMICS 1996, Vol 47, Iss 1, pp 109-114

Burton-MP Phimister-E, "Core Journals - A Reappraisal of the Diamond List", ECONOMIC JOURNAL,1995, Vol 105, Iss 429, pp 361-373

Buschbeck-K, "The Reunification of German Research and Science", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS,1993, Vol 25, Iss 3, pp 27-31

Butler-D, "French Citations Forge Ahead But Europe Still Loses Ground", NATURE 1996, Vol 379, Iss 6566, pp 575-575

Butler-D, "Peer-Review Still Essential, Say Researchers", NATURE 1996, Vol 379, Iss 6568, pp 758-758

Butler-JN, "Mass and Charge Balances Clarify Ionic Equilibrium Calculations - A Citation-Classic Commentary on Ionic Equilibrium - A Mathematical Approach by Butler,J.N.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 20, pp 8-8

Butler-RN, "Autopsy - The Final Peer-Review", GERIATRICS,1991, Vol 46, Iss 12, pp 11-12

Buzbee-B, "Poissons-Equation Revisited - A Citation-Classic Commentary on on Direct Methods for Solving Poissons Equations by Buzbee,B.L., Golub,G.H., and Nielson,C.W.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 36, pp 8-8

BWHO, "Scientific Output in Health-Sciences in Latin-America, 1973-92", BULLETIN OF THE WORLD HEALTH ORGANIZATION 1995, Vol 73, Iss 5, pp 718-720

Byerly-L, "Hagiwara and Calcium Channels - A Citation-Classic Commentary on Calcium-Channel by Hagiwara,S., and Byerly,L.", CURRENT

CONTENTS/LIFE SCIENCES,1992, Iss 20, pp 9-9

Byrd-GD, "Peer-Review in Scientific Publishing - Papers from the 1st International-Congress on Peer-Review in Biomedical Publication, by Council-Of-Biol-Editors", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1992, Vol 80, Iss 2, pp 206-207

Byrd-WM Clayton-LA Kinchen-K Richardson-D Lawrence-L Butcher-R Davidson-E, "African-American Physicians - Views on Health Reform - Results of a Survey", JOURNAL OF THE NATIONAL MEDICAL ASSOCIATION,1994, Vol 86, Iss 3, pp 191-199

Byrt-T Bishop-J Carlin-JB, "Bias, Prevalence and Kappa", JOURNAL OF CLINICAL EPIDEMIOLOGY,1993, Vol 46, Iss 5, pp 423-429

Cadoret-RJ, "Adoption Studies", ALCOHOL HEALTH & RESEARCH WORLD 1995, Vol 19, Iss 3, pp 195-200

Caelleigh-AS, "In Progress - Reports of New Approaches to Medical-Education - An Annual, Peer-Reviewed Collection of Reports on Innovative Approaches to Medical-Education - Foreword", ACADEMIC MEDICINE,1994, Vol 69, Iss 5, pp 405-405

Cagnin-MAH, "The State of Scientific-Research in Chemistry - A View from the Brazilian Community", INTERCIENCIA,1993, Vol 18, Iss 3, pp 146-154

Cahill-GF, "A Review of Starvation - A Citation-Classic Commentary on Starvation in Man, by Cahill,G.F.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 28, pp 10-10

Calhoun-JC, "Serials Citations and Holdings Correlation", LIBRARY RESOURCES & TECHNICAL SERVICES,1995, Vol 39, Iss 1, pp 53-77

Callon-M Courtial-JP Laville-F, "Co-Word Analysis As a Tool for Describing the Network of Interactions Between Basic and Technological Research - The Case of Polymer Chemistry", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 155-205

Calne-DB Calne-R, "Citation of Original Research", LANCET,1992, Vol 340, Iss 8813, pp 244-244

Cambrosio-A Limoges-C Courtial-JP Laville-F, "Historical Scientometrics - Mapping over 70 Years of Biological Safety Research with Co-Word Analysis", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 119-143

Cami-J Fernandez-MT Caridad-IG, "The Spanish Scientific Production in Biomedicine and Health-Care - A Study Through the Science-Citation-Index (1986-1989)", MEDICINA CLINICA,1993, Vol 101, Iss 19, pp 721-731

Campanario-JM, "Consolation for the Scientist - Sometimes It Is Hard to Publish Papers That Are Later Highly-Cited", SOCIAL STUDIES OF SCIENCE,1993, Vol 23, Iss 2, pp 342-362

Campanario-JM, "Have Referees Rejected Some of the Most-Cited Articles of All Times", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 4, pp 302-310

Campanario-JM, "On Influential Books and Journal Articles Initially Rejected Because of Negative Referees Evaluations", SCIENCE COMMUNICATION,1995, Vol 16, Iss 3, pp 304-325

Campanario-JM, "Using Citation-Classics to Study the Incidence of Serendipity in Scientific Discovery", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 3-24

Campo-JV Fritsch-SL, "Somatization in Children and

Adolescents", JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY,1994, Vol 33, Iss 9, pp 1223-1235
Campos-C Redondo-FL, "Bibliometrics and Clinical-Chemistry", CLINICAL CHEMISTRY,1991, Vol 37, Iss 2, pp 303-304
Campos-C Redondo-FL, "Bibliometrics and Clinical-Chemistry", CLINICAL CHEMISTRY,1991, Vol 37, Iss 2, pp 303-304
Canessa-GS Rivas-BL,"Boletin-de-La-Sociedad-Chilena-de-Quimica in Its 45Th Anniversary", BOLETIN DE LA SOCIEDAD CHILENA DE QUIMICA,1994, Vol 39, Iss 4, pp 255-262
Cano-F Julian-S, "Some Indicators in Spanish Scientific Production", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 43-59
Cano-V Lind-NC, "Citation Life-Cycles of 10 Citation-Classics", SCIENTOMETRICS,1991, Vol 22, Iss 2, pp 297-312
Caraca-JMG Dasilva-CM Massimo-L, "Research-and-Development Indicators and Socioeconomic Cohesion", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 293-309
Caraveo-JJ Espinosa-MG Hernandez-GS Ruelas-EG, "National Survey of Hospitalized Psychiatric-Patients", SALUD MENTAL 1995, Vol 18, Iss 4, pp 1-9
Carbone-P, "The Committee Draft of International Standard iso-Cd-
11620 on Library Performance Indicators", IFLA JOURNAL-INTERNATIONAL FEDERATION OF LIBRARY ASSOCIATIONS 1995, Vol 21, Iss 4, pp 274+
Cardinal-DN Drew-DE, "Institutional and Faculty Influences on the Reputation of Doctorate-Granting Programs in Special-Education", JOURNAL OF SPECIAL EDUCATION,1993, Vol 27, Iss 1, pp 52-65
Carley-KM Hummon-NP Harty-M, "Scientific Influence - An Analysis of the Main Path Structure in the Journal of Conflict-Resolution", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1993, Vol 14, Iss 4, pp 417-447
Carlton-PL Strawderman-WE, "Evaluating Cumulated Research .1. The Inadequacy of Traditional Methods", BIOLOGICAL PSYCHIATRY 1996, Vol 39, Iss 1, pp 65-72
Carrier-S Roskies-E, "Multiple Roles for Women", CANADIAN PSYCHOLOGY-PSYCHOLOGIE CANADIENNE,1993, Vol 34, Iss 1, pp 26-44
Carruth-J, "Shea,John - Citation for an Honorary Fellowship of the Royal-College-of-Surgeons of England", JOURNAL OF LARYNGOLOGY AND OTOLOGY,1992, Vol 106, Iss 12, pp 1033-1034
Carta-JJ Sideridis-G Rinkel-P Guimaraes-S Greenwood-C Baggett-K Peterson-P Atwater-J Mcevoy-M Mcconnell-S, "Behavioral Outcomes of Young-Children Prenatally Exposed to Illicit Drugs - Review and Analysis of Experimental Literature", TOPICS IN EARLY CHILDHOOD SPECIAL EDUCATION,1994, Vol 14, Iss 2, pp 184-216
Carter-N Greer-P, "Evaluating Agencies - Next Steps and Performance Indicators", PUBLIC ADMINISTRATION,1993, Vol 71, Iss 3, pp 407-416
Carter-S, "Index to Legal Citations and Abbreviations, 2nd Edition, by D. Raistrick", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1994, Vol 26, Iss 3, pp 171-172
Carton-RJ, "National Toxicology Program - Critique of Peer-Review Draft Report", FLUORIDE,1991, Vol 24, Iss 3, pp 85-89
Case-SM Ripkey-DR Swanson-DB Andreatta-AG Barry-W

Carlson-P Davis-W Edwards-J Epps-A Feldman-L Fincher-RM Mccahan-J Mcmahon-T Mosely-J Peppler-R Pestana-C Perkowski-L Smith-J Smith-M Titusdillon-P Waechter-D Wheeler-R Willoughby-TL, "The Relationship Between Clinical Science Performance in 20 Medical-Schools and Performance on Step 2 of the Usmle Licensing Examination", ACADEMIC MEDICINE 1996, Vol 71, Iss 1, pp S31-S33

Caswell-JV Gulden-FH Parsons-KA Wendell-DC Wiese-WH, "Importance and Use of Holding Links Between Citation Databases and Online Catalogs", JOURNAL OF ACADEMIC LIBRARIANSHIP,1995, Vol 21, Iss 2, pp 92-96

Catte-P Mastropasqua-C, "Financial Structure and Reforms in Central and Eastern-Europe in the 1980s", JOURNAL OF BANKING & FINANCE,1993, Vol 17, Iss 5, pp 785-817

Cava-RJ, "The Identification of the 1st 90-K Superconductor - A Citation-Classic Commentary on Bulk Superconductivity at 91-K in Single-Phase Oxygen-Deficient Perovskite Ba2Ycu3O9-Delta by Cava,R.J., Batlogg,B., Vandover,R.B., Murphy,D.W., Sunshine,S., Siegrist,T., Remeika,J.P., Rietman,E.A., Zahurak,S., Espinosa,G.P.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 14, pp 8-9

Cawley-R Tarsh-M, "Peer-Review of Psychosurgery - Stereotaxic Subcaudate Tractotomy - An Indispensable Treatment", BRITISH JOURNAL OF PSYCHIATRY,1994, Vol 165, Iss NOV, pp 612-613

Cerezo-MA Frias-D, "Emotional and Cognitive Adjustment in Abused-Children", CHILD ABUSE & NEGLECT,1994, Vol 18, Iss 11, pp 923-932

Cesaratto-S Mangano-S Sirilli-G, "The Innovative Behavior of Italian Firms - A Survey on Technological Innovation and Research-and-Development", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 115-141

Chakrabarti-AK Dror-I, "Technology Transfers and Knowledge Interactions Among Defense Firms in the USA - An Analysis of Patent Citations", INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT,1994, Vol 9, Iss 5-7, pp 757-770

Chakrabarti-AK Dror-I Eakabuse-N, "Interorganizational Transfer of Knowledge - An Analysis of Patent Citations of a Defense Firm", IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT,1993, Vol 40, Iss 1, pp 91-94

Chamness-GC, "Interpreting Ligand-Binding Data - A Citation-Classic Commentary on Scatchard Plots - Common Errors in Correction and Interpretation by Chamness,G.C., and Mcguire,W.L.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 20, pp 8-8

Chan-F Rosen-AJ Wong-DW Kaplan-S, "Evaluating Rehabilitation Caseload Management-Skills Through Computer-Simulations", JOURNAL OF COUNSELING AND DEVELOPMENT,1993, Vol 71, Iss 5, pp 493-498

Chandy-PR Williams-TGE, "The Impact of Journals and Authors on International-Business Research - A Citational Analysis of Jibs Articles", JOURNAL OF INTERNATIONAL BUSINESS STUDIES,1994, Vol 25, Iss 4, pp 715-728

Chang-JY, "Protein Sequencing at the Picomole Level Using Color Edman Reagent - A Citation-Classic Commentary on Micro-Sequence

Analysis of Peptides and Proteins Using 4-NN-Dimethylaminoazobenzene 4'-Isothiocyanate Phenylisothiocyanate Double Coupling Method, by Chang,J.Y., Brauer,D., and Whittmannliebold,B.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 24, pp 9-10

Chapman-K, "Variability of Degree Results in Geography in United-Kingdom Universities 1973-90 - Preliminary-Results and Policy Implications", STUDIES IN HIGHER EDUCATION,1994, Vol 19, Iss 1, pp 89-102

Chapman-LJ Murphy-DJ Kiernan-NE Goldenhar-L, "An Improved Model for Professional Conferences and Workshops", AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 1996, Vol 29, Iss 4, pp 342-345

Chatelin-Y Arvanitis-R, "Representing Scientific Activity by Structural Indicators - The Case of Cote-Divoire 1884-1968", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 235-247

Chebat-JC, "Special Issue on Strategy Evaluation Research", JOURNAL OF BUSINESS RESEARCH,1994, Vol 31, Iss 2-3, pp 91-92

Chen-HT Marks-MR Bersani-CA, "Unemployment Classifications and Subjective Well-Being", SOCIOLOGICAL REVIEW,1994, Vol 42, Iss 1, pp 62-78

Chen-JC, "The Bluebook - A Uniform System of Citation, by Harvard-Law-Review-Assoc", UNIVERSITY OF CHICAGO LAW REVIEW,1991, Vol 58, Iss 4, pp 1527-1540

Chen-JH Simeonsson-RJ, "Prevention of Childhood Disability in the Peoples-Republic-of-China", CHILD CARE HEALTH AND DEVELOPMENT,1993, Vol 19, Iss 2, pp 71-88

Chen-YS Chong-PP Tong-YG, "Theoretical Foundation of the 80/20 Rule", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 183-204

Chen-YS Chong-PP Tong-MY, "The Simon-Yule Approach to Bibliometric Modeling", INFORMATION PROCESSING & MANAGEMENT,1994, Vol 30, Iss 4, pp 535-556

Cheng-CH Holsapple-CW Lee-A, "Citation-Based Journal Rankings for AI Research - A Business Perspective", AI MAGAZINE 1996, Vol 17, Iss 2, pp 87-97

Cheng-CH Holsapple-CW Lee-A, "Citation-Based Journal Rankings for Expert-System Research", EXPERT SYSTEMS 1995, Vol 12, Iss 4, pp 313-322

Chenok-PB, "Standards Overload and Peer-Review - Reply", JOURNAL OF ACCOUNTANCY,1991, Vol 171, Iss 3, pp 16-16

Cheon-MJ Grover-V Sabherwal-R, "The Evolution of Empirical-Research in Is - A Study in Is Maturity", INFORMATION & MANAGEMENT,1993, Vol 24, Iss 3, pp 107-119

Chernysheva-LV, "Use of CO-Nomination Analysis for the Design of Scientific Collaboration Map in the Field of Cryobiology", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 2-INFORMATSIONNYE PROTSESSY I SISTEMY,1991, Iss 11, pp 27-32

Chew-FS, "Manuscript Peer-Review - General Concepts and the Ajr Process", AMERICAN JOURNAL OF ROENTGENOLOGY,1993, Vol 160, Iss 2, pp 409-411

Chi-MTH, "Experts vs Novices Knowledge - A Citation-Classic Commentary on Categorization and Representation of Physics Problems by Experts and Novices by Chi,M.T.H., Feltovich,P., Glaser,R.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 42, pp 8-8

Childrens Books", LIBRARY TRENDS 1996, Vol 44, Iss 4, pp 755-775

Ching-TYC Williams-R Vanhasselt-A, "Communication of Lexical Tones in Cantonese Alaryngeal Speech", JOURNAL OF SPEECH AND HEARING RESEARCH,1994, Vol 37, Iss 3, pp 557-571

Chitty-D, "An Alternative to Density-Dependence - A Citation-Classic Commentary on the Natural-Selection of Self-Regulatory Behavior in Animal Populations by Chitty,D.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 22, pp 8-8

Chitty-D, "Vole Populations - A Model for Others - A Citation-Classic Commentary on Population Processes in the Vole and Their Relevance to General-Theory by Chitty,D.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 20, pp 10-10

Chomczynski-P, "Necessity Breeds Invention - Single-Step RNA Isolation - A Citation-Classic Commentary on Single-Step Method of RNA Isolation by Acid Guanidinium Thiocyanate-Phenol-Chloroform Extraction by Chomczynski,P., and Sacchi,N.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 36, pp 8-8

Chressanthis-GA Chressanthis-JD, "The Relationship Between Manuscript Submission Fees and Journal Quality", SERIALS LIBRARIAN,1993, Vol 24, Iss 1, pp 71-86

Chressanthis-GA Chressanthis-JD, "A General Econometric-Model of the Determinants of Library Subscription Prices of Scholarly Journals - The Role of Exchange-Rate Risk and Other Factors", LIBRARY QUARTERLY,1994, Vol 64, Iss 3, pp 270-293

Christensen-FH Ingwersen-P, "Online Citation Analysis - A Methodological Approach", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 39-62

Christensen-G, "Daphnia as Little White-Rats - A Citation-Classic Commentary on Effects of Various Metals on Survival, Growth, Reproduction, and Metabolism of Daphnia-Magna by Biesinger,K.E. and Christensen,G.M.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 36, pp 8-8

Christianson-EH, "Birth and Development of Global Science - Production and Reproduction of Scientific Communities in Europe and Latin-America - French, by X. Polanco", ISIS,1991, Vol 82, Iss 314, pp 712-713

Chrzastowski-T, "Citation Caution - Reply", CHEMISTRY & INDUSTRY,1993, Iss 15, pp 562-562

Chu-H, "Communication Between Chinese and Non-Chinese Scientists in the Discovery of High-Tc Superconductors .2. The Informal Perspective", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 253-277

Chu-H, "Communication Between Chinese and Non-Chinese Scientists in the Discovery of High-Tc Superconductor .1. The Formal Perspective", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 229-252

Chubin-DE, "Grants Peer-Review in Theory and Practice", EVALUATION REVIEW,1994, Vol 18, Iss 1, pp 20-30

Chubin-DE, "Undergraduate Science-Education", CHEMICAL & ENGINEERING NEWS,1993, Vol 71, Iss 12, pp 5-5

Chubin-DE Robinson-EM, "Data on the Federal Research System in the United-States - Whats Known and Whats Not", KNOWLEDGE-CREATION

DIFFUSION UTILIZATION,1991, Vol 13, Iss 1, pp 49-78

Chung-KH Pak-HS Cox-RAK, "Patterns of Research Output in the Accounting Literature - A Study of the Bibliometric Distributions", ABACUS-A JOURNAL OF ACCOUNTING AND BUSINESS STUDIES,1992, Vol 28, Iss 2, pp 168-185

Chung-KH Puelz-R, "An Empirical Regularity in the Market for Risk and Insurance Research Output", JOURNAL OF RISK AND INSURANCE,1992, Vol 59, Iss 3, pp 489-498

Chung-YK, "Bradford Distribution and Core Authors in Classification Systems Literature", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 253-269

Churbanova-SM, "Research of Productivity Phenomenon in Divergent Task Solving by Preschoolers", INTERNATIONAL JOURNAL OF PSYCHOLOGY,1992, Vol 27, Iss 3-4, pp 157-157

Church-RM Crystal-JD Collyer-CE, "Correction of Errors in Scientific-Research", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS 1996, Vol 28, Iss 2, pp 305-310

Chute-DL Westall-RF, "5th-Generation Research Tools - Collaborative Development with Powerlaboratory", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS 1996, Vol 28, Iss 2, pp 311-314

Cicchetti-DV, "Reflections from the Peer-Review Mirror", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 167-186

Cicchetti-DV, "The Reliability of Peer-Review for Manuscript and Grant Submissions - Its Like Deja-Vu All over Again - Authors Response", BEHAVIORAL AND BRAIN SCIENCES,1993, Vol 16, Iss 2, pp 401-403

Cicchetti-DV, "The Reliability of Peer-Review for Manuscript and Grant Submissions - Its Like Deja-Vu All over Again - Authors Response", BEHAVIORAL AND BRAIN SCIENCES,1993, Vol 16, Iss 2, pp 401-403

Cicchetti-DV, "The Reliability of Peer-Review for Manuscript and Grant Submissions - A Cross-Disciplinary Investigation", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 119-134

Cicchetti-DV Rourke-BP Wass-P, "Peer-Review for Manuscript and Grant Submissions - Relevance for Research in Clinical Neuropsychology", JOURNAL OF CLINICAL AND EXPERIMENTAL NEUROPSYCHOLOGY,1992, Vol 14, Iss 6, pp 976-980

Clark-MJR, "Misleading Citation Indexes", CHEMTECH,1993, Vol 23, Iss 1, pp 3-3

Clark-MJR, "More on Citations", CHEMTECH,1993, Vol 23, Iss 9, pp 3-3

Clement-E Ogburn-JL, "Searching Georef for Archaeology", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN 1995, Vol 14, Iss 1, pp 1-10

Climaco-C, "Getting to Know Schools Using Performance Indicators - Criteria, Indicators and Processes", EDUCATIONAL REVIEW,1992, Vol 44, Iss 3, pp 295-308

Clinch-P, "The Use of Authority - Citation Patterns in the English Courts", JOURNAL OF DOCUMENTATION1990, Vol 46, Iss 4, pp 287-317

Cluttonbrock-TH, "Primate Rules OK - A Citation-Classic Commentary on Primate Ecology and Social-Organization by Cluttonbrock,T.H., Harvey,P.", CURRENT CONTENTS/AGRICULTURE BIOLOGY

& ENVIRONMENTAL SCIENCES,1993, Iss 26, pp 8-8

Cluttonbrock-TH, "The Ecology of 2 Sexes - A Citation-Classic Commentary on Red Deer - Behavior and Ecology of 2 Sexes by Cluttonbrock,T.H., Guinness,F.E., and Albon,S.D.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 28, pp 8-8

Cnaan-RA Caputo-RK Shmuely-Y, "Senior Faculty Perceptions of Social-Work Journals", JOURNAL OF SOCIAL WORK EDUCATION,1994, Vol 30, Iss 2, pp 185-199

Cockburn-I Henderson-R, "Public-Private Interaction in Pharmaceutical Research", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 1996, Vol 93, Iss 23, pp 12725-12730

Cockcroft-DW, "A Measured Breath - A Citation-Classic Commentary on Bronchial Reactivity to Inhaled Histamine - A Method and Clinical Survey by Cockcroft,D.W., Killian,D.N., Mellon,J.J.A. and Hargreave,F.E.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 32, pp 10-10

Cockcroft-DW, "Creatinine Clearance Prediction - A Citation-Classic Commentary on Prediction of Creatinine Clearance from Serum Creatinine by Cockcroft,D.W., and Gault,M.H.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 48, pp 8-8

Cockcroft-DW, "The Secret of Allergen-Induced Asthma - A Citation-Classic Commentary on Allergen-Induced Increase in Nonallergic Bronchial Reactivity by Cockcroft,D.W., Ruffin,R.E., Dolovich,J., and Hargreave,F.E.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 8, pp 8-8

Cockton-P, "Cataloging the 19th-Century British Parliamentary Papers - An Introduction to the Subject Catalog of the House-of-Commons Parliamentary Papers, 1801-1900", GOVERNMENT PUBLICATIONS REVIEW,1993, Vol 20, Iss 4, pp 413-420

Coghlan-A, "British Peer-Review System Too Secretive", NEW SCIENTIST,1991, Vol 129, Iss 1753, pp 18-18

Coghlan-A, "Citation System May Encourage Banal Research", NEW SCIENTIST,1991, Vol 130, Iss 1768, pp 13-13

Cohen-G Hochstein-P, "Bringing an Enzyme Out of the Closet - A Citation-Classic Commentary on Glutathione-Peroxidase - The Primary Agent for the Elimination of Hydrogen-Peroxide in Erythrocytes by Cohen,G. and Hochstein,P.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 16, pp 9-9

Cohen-H, "Citation of Drafts Questioned - Reply", AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL 1996, Vol 57, Iss 6, pp 580-580

Cohen-J, "AIDS Funding - Microgenesis Vaccine Trial Gets a Public Peer-Review", SCIENCE,1992, Vol 258, Iss 5085, pp 1079-1080

Cohen-J, "AIDS Trials Take on Peer-Review (Vol 271, Pg 20, 1996)", SCIENCE 1996, Vol 271, Iss 5249, pp 583-583

Cohen-J, "Computer-Mediated Communication and Publication Productivity Among Faculty", INTERNET RESEARCH-ELECTRONIC NETWORKING APPLICATIONS AND POLICY 1996, Vol 6, Iss 2-3, pp 41+

Cohen-J, "Microgenesys - Peer-Review Triumphs over Lobbying", SCIENCE,1994, Vol 263, Iss 5146, pp 463-463

Cohen-J Dannefer-EF Seidel-HM Weisman-CS Wexler-P Brown-TM Brieger-GH Margolis-S Ross-LR Kunitz-SJ, "Medical-Education Change - A Detailed Study of 6 Medical-Schools", MEDICAL EDUCATION,1994, Vol 28, Iss 5, pp 350-360

Cohen-JE, "Size, Age and Productivity of Scientific and Technical Research Groups", SCIENTOMETRICS,1991, Vol 20, Iss 3, pp 395-416

Cohen-S, "Social Support, Stress, and Health - A Citation-Classic Commentary on Stress, Social Support, and the Buffering Hypothesis by Cohen,S., and Wills,T.A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 28, pp 8-8

Cohen-SA, "Modern Methods for Amino-Acid-Analysis - A Citation-Classic Commentary on Rapid Analysis of Amino-Acids Using Precolumn Derivatization by Bidlingmeyer,B.A., Cohen,S.A., Tarvin,T.L.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 50, pp 9-9

Cohn-EG Farrington-DP, "The Validity of Citations as a Measure of Influence in Criminology", BRITISH JOURNAL OF CRIMINOLOGY,1995, Vol 35, Iss 1, pp 143-145

Cohn-EG Farrington-DP, "Who Are the Most-Cited Scholars in Major American Criminology and Criminal-Justice Journals", JOURNAL OF CRIMINAL JUSTICE,1994, Vol 22, Iss 6, pp 517-534

Cohn-EG Farrington-DP, "Who Are the Most Influential Criminologists in the English-Speaking World", BRITISH JOURNAL OF CRIMINOLOGY,1994, Vol 34, Iss 2, pp 204-225

Cohn-EG Farrington-DP, "Crime and Justice and the Criminal-Justice and Criminology Literature", CRIME AND JUSTICE-A REVIEW OF RESEARCH 1996, Vol 20, pp 265-300

Colaianni-LA, "Peer-Review in Journals Indexed in Index-Medicus", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 156-158

Cole-S, "Consensus and the Reliability of Peer-Review Evaluations", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 140-140

Cole-S, "Peerless Science - Peer-Review and United-States SciencePolicy, by D.E. Chubin, E.J. Hackett", CONTEMPORARY SOCIOLOGY-AN INTERNATIONAL JOURNAL OF REVIEWS,1991, Vol 20, Iss 4, pp 603-605

Coleman-SR, "Bradford Distributions of Social-Science Bibliographies Varying in Definitional Homogeneity", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 75-91

Coleman-SR, "Disciplinary Variables That Affect the Shape of Bradford Bibliography", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 59-81

Coleman-SR, "The Laboratory as a Productivity and Citation Unit in the Publications of an Experimental-Psychology Specialty", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 9, pp 639-643

Collins-D Doherty-M Talbot-S, "Performance Enhancement in Motocross - A Case-Study of the Sport Science Team in Action", SPORT PSYCHOLOGIST,1993, Vol 7, Iss 3, pp 290-297

Collins-J Rugg-D Kann-L Banspach-S Kolbe-L, "Evaluating a National Program of School-Based HIV Prevention", EVALUATION AND

PROGRAM PLANNING 1996, Vol 19, Iss 3, pp 209-218

Collins-PMD Ringe-MJ, "Europeanization of the Market for Contract Research", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 283-289

Colman-AM, "Unreliable Peer-Review - Causes and Cures of Human Misery", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 141-141

Colman-AM Dhillon-D Coulthard-B, "A Bibliometric Evaluation of the Research Performance of British University Politics Departments - Publications in Leading Journals", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 49-66

Colman-AM Garner-AB Jolly-S, "Research Performance of United-Kingdom University Psychology Departments", STUDIES IN HIGHER EDUCATION,1992, Vol 17, Iss 1, pp 97-103

Colman-AM Grant-SP Henderson-E, "Performance of British University Psychology Departments as Measured by Number of Publications in BPS Journals", CURRENT PSYCHOLOGY-RESEARCH & REVIEWS,1993, Vol 11, Iss 4, pp 360-368

COMMUNICATIONS OF THE ACM, Siguccs Peer-Review Program Going Strong After More Than 10 Years", COMMUNICATIONS OF THE ACM,1992, Vol 35, Iss 7, pp 2-2

Conn-HO, "Peer-Review of a Biomedical Article - Unnecessary Hassle", ITALIAN JOURNAL OF GASTROENTEROLOGY,1992, Vol 24, Iss 2, pp 85-86

Connell-JH, "The Profound Effect of a Pioneer French Ecologist - A Citation-Classic Commentary on Effects of Competition, Predation by Thais-Lapillus and Other Factors on Natural-Populations of the Barnacle Balanus-Balanoides by Connell,J.H.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 24, pp 8-8

Connorgreene-PA, "From the Laboratory to the Headlines - Teaching Critical-Evaluation of Press Reports of Research", TEACHING OF PSYCHOLOGY,1993, Vol 20, Iss 3, pp 167-169

Conture-EG Guitar-BE, "Evaluating Efficacy of Treatment of Stuttering - School-Age-Children", JOURNAL OF FLUENCY DISORDERS,1993, Vol 18, Iss 2-3, pp 253-287

Cooley-JW Tukey-JW, "On the Origin and Publication of the FFT Paper - A Citation-Classic Commentary on an Algorithm for the Machine Calculation of Complex Fourier-Series by Cooley,J.W., and Tukey,J.W.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 51-52, pp 8-9

Cooper-MD Mcgregor-GF, "Using Article Photocopy Data in Bibliographic Models for Journal Collection Management", LIBRARY QUARTERLY,1994, Vol 64, Iss 4, pp 386-413

Cooper-R, "The Status and Future of Audience Duplication Research - An Assessment of Ratings-Based Theories of Audience Behavior", JOURNAL OF BROADCASTING & ELECTRONIC MEDIA 1996, Vol 40, Iss 1, pp 96-111

Cooper-RB Blair-D Pao-M, "Communicating MIS Research - A Citation Study of Journal Influence", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 1, pp 113-127

Correia-ME Reisig-MD Lovrich-NP, "Public Perceptions of State Police - An Analysis of Individual-Level and Contextual Variables",

JOURNAL OF CRIMINAL JUSTICE 1996, Vol 24, Iss 1, pp 17-28

Coscina-DV, "Research on Feeding-Behavior - Quantitative Information vs Qualitative Perceptions About Where It Is Published", NEUROSCIENCE AND BIOBEHAVIORAL REVIEWS,1993, Vol 17, Iss 1, pp 13-19

Cote-JA Leong-SM Cote-J, "Assessing the Influence of Journal of Consumer Research -A Citation Analysis", JOURNAL OF CONSUMER RESEARCH,1991, Vol 18, Iss 3, pp 402-410

Cottaschonberg-M Line-MB, "Evaluation of Academic-Libraries - With Special Reference to the Copenhagen-Business-School-Library", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1994, Vol 26, Iss 2, pp 55-69

Cotton-P, "Flaws Documented, Reforms Debated at Congress on Journal Peer-Review (Vol 270, Pg 2775, ,1993)", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 1, pp 11-11

Cotton-P, "Flaws Documented, Reforms Debated at Congress on Journal Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1993, Vol 270, Iss 23, pp 2775+

Coura-JR, "The Scientific Production and International Reputation of Travassos,Lauro", MEMORIAS DO INSTITUTO OSWALDO CRUZ,1992, Vol 87, Iss S1, pp R7-R10

Courtial-JP, "A Validation-Study of Leximappe - Comment", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 313-316

Courtial-JP, "A Coword Analysis of Scientometrics", SCIENTOMETRICS,1994, Vol 31, Iss 3, pp 251-260

Courtial-JP Cahlik-T Callon-M, "A Model for Social-Interaction Between Cognition and Action Through a Key-Word Simulation of Knowledge Growth", SCIENTOMETRICS,1994, Vol 31, Iss 2, pp 173-192

Courtial-JP Callon-M, "Indicators for the Identification of Strategic Themes Within a Research-Program", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 447-458

Courtial-JP Callon-M Sigogneau-A, "The Use of Patent Titles for Identifying the Topics of Invention and Forecasting Trends", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 231-242

Courtois-MP Matthews-JA, "Tips for Searching the ISI Citation Indexes for Personnel Decisions", DATABASE-THE MAGAZINE OF DATABASE REFERENCE AND REVIEW,1993, Vol 16, Iss 3, pp 60-&

Cowman-S, "Student Evaluation - A Performance Indicator of Quality in Nurse Education", JOURNAL OF ADVANCED NURSING 1996, Vol 24, Iss 3, pp 625-632

Cox-BJ Wessel-I Norton-GR Swinson-RP, "Citation Patterns in Anxiety Disorders Research in 14 Journals - 1990-,1991", AMERICAN JOURNAL OF PSYCHIATRY,1994, Vol 151, Iss 6, pp 933-936

Cox-D Gleser-L Perlman-M Reid-N Roeder-K, "Report of the AD-Hoc-Committee-on-Double-Blind-Refereeing", STATISTICAL SCIENCE,1993, Vol 8, Iss 3, pp 310-317

Cozzens-S, "Us Research Assessment - Recent Developments", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 351-362

Cozzens-SE, "American Science Policy Since World-War-II, by B.L.R. Smith", TECHNOLOGY AND CULTURE,1993, Vol 34, Iss 1, pp 191-192

Cozzens-SE, "Social-Scientists, Policy, and the State, by S. Brooks, A.G. Gagnon", SOCIAL FORCES,1992, Vol 71, Iss 2, pp 529-530

Craig-B, "SPE Peer-Review Critique", JOURNAL OF PETROLEUM

TECHNOLOGY,1994, Vol 46, Iss 7, pp 563-563

Cram-DL Stebbins-M Eom-HS Ratto-N Sugiyama-D, "Peer-Review as a Quality Assurance Mechanism in 3 Pharmacist-Run Medication-Refill Clinics", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1992, Vol 49, Iss 11, pp 2727-2730

Crandall-R, "The Gatekeepers of Psychology - Evaluation of Peer-Review, by E.R. Harcum, E.F. Rosen", CONTEMPORARY PSYCHOLOGY,1994, Vol 39, Iss 11, pp 1043-1044

Crane-AB Ginsburg-S, "Evaluation in the Health Resources and Services Administration - Improving Program Performance", EVALUATION & THE HEALTH PROFESSIONS 1996, Vol 19, Iss 3, pp 325-341

Cristofalo-VJ, "Cell Senescence in Culture - The Definition of Replicative Age - A Citation-Classic Commentary on Cellular Senescence and DNA-Synthesis - Thymidine Incorporation as a Measure of Population Age in Human-Diploid Cells by Cristofalo,V.J., Sharf,B.B.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 42, pp 8-8

Croft-WB Turtle-HR, "Retrieval Strategies for Hypertext", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 3, pp 313-324

Cronin-B, "Informetrics-91 - Selected Papers from the 3rd International-Conference on Bibliometrics, 9-12 August ,1991, Bangalore, by R.K. Rao", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1993, Vol 25, Iss 4, pp 216-216

Cronin-B, "Rates of Return to Citation", JOURNAL OF DOCUMENTATION 1996, Vol 52, Iss 2, pp 188-197

Cronin-B, "Tiered Citation and Measures of Document Similarity", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 7, pp 537-538

Cronin-B Davenport-E, "Conflicts of Jurisdiction - An Exploratory-Study of Academic, Professional, and Epistemological Norms in Library and Information-Science", LIBRI 1996, Vol 46, Iss 1, pp 1-15

Cronin-B Mckenzie-G Rubio-L Weaverwozniak-S, "Accounting for Influence - Acknowledgments in Contemporary Sociology", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 7, pp 406-412

Cronin-B Overfelt-K, "Citation-Based Auditing of Academic-Performance", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 2, pp 61-72

Cross-BE, "Inaccurate Citation Regretted - Reply", EDUCATIONAL LEADERSHIP,1993, Vol 51, Iss 2, pp 84-84

Crossan-M Guatto-T, "Organizational Learning Research Profile", JOURNAL OF ORGANIZATIONAL CHANGE MANAGEMENT 1996, Vol 9, Iss 1, pp 107+

Crothers-C, "Peer-Review Reliability - The Hierarchy of the Sciences", BEHAVIORAL AND BRAIN SCIENCES,1993, Vol 16, Iss 2, pp 398-399

Crow-TJ, "2 Syndromes in Schizophrenia and Their Underlying Pathology - A Citation-Classic Commentary on Molecular Pathology of Schizophrenia - More Than One Disease Process by Crow,T.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 48, pp 9-9

Crowne-DP, "From Response Style to Motive - A Citation-Classic Commentary on the Approval Motive - Studies in Evaluative Dependence

by Crowne,D.P. and Marlowe,D.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 30, pp 10-10

Csef-H, "Psychoanalytic Treatment of Anxiety. Disorders - Treatment Concepts and Results of Evaluation Research", ZEITSCHRIFT FUR KLINISCHE PSYCHOLOGIE PSYCHOPATHOLOGIE UND PSYCHOTHERAPIE,1994, Vol 42, Iss 2, pp 139-156

Cullars-J, "Citation Characteristics of Monographs in the Fine-Arts", LIBRARY QUARTERLY,1992, Vol 62, Iss 3, pp 325-342

Cullars-JM, "Citation Characteristics of French and German Fine-Arts Monographs", LIBRARY QUARTERLY 1996, Vol 66, Iss 2, pp 138-160

Cullen-DJ Macaulay-A, "Consistency Between Peer Reviewers for a Clinical Specialty Journal", ACADEMIC MEDICINE,1992, Vol 67, Iss 12, pp 856-859

Cullen-RJ Calvert-PJ, "Stakeholder Perceptions of University-Library Effectiveness", JOURNAL OF ACADEMIC LIBRARIANSHIP 1995, Vol 21, Iss 6, pp 438-448

Cullis-PR Dekruijff-B, "Lipid Polymorphism - A Citation-Classic Commentary on Lipid Polymorphism and the Functional Roles of Lipids in Biological-Membranes by Cullis,P.R., Dekruijff,B.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 42, pp 11-11

Cunion-KM, "UK Government Departments Experience of RT-and-D Program-
Evaluation and Methodology", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 363-374

Cunliffe-B Harding-A Austin-D, "The 1996 Research Assessment Exercise in British Universities - Views from the Judging and the Judged", ANTIQUITY 1996, Vol 70, Iss 268, pp 250-250

Cunningham-JJ, "Effective Audiovisual Presentation - Proper Citation of Sources", AMERICAN JOURNAL OF ROENTGENOLOGY,1991, Vol 157, Iss 3, pp 643-643

Curran-P, "The Slope of the Playing Field", AREA,1994, Vol 26, Iss 3, pp 249-260

Curtis-KL Weller-AC Hurd-JM, "Information-Seeking Behavior - A Survey of Health-Sciences Faculty Use of Indexes and Databases", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol 81, Iss 4, pp 383-392

Curzon-G, "The History of Neurochemistry as Revealed by the Journal of Neurochemistry", JOURNAL OF NEUROCHEMISTRY,1993, Vol 61, Iss 2, pp 780-786

Cuttance-P, "Monitoring Educational Quality Through Performance Indicators for School Practice", SCHOOL EFFECTIVENESS AND SCHOOL IMPROVEMENT,1994, Vol 5, Iss 2, pp 101-126

Czapski-G Frenkel-A Kohn-D Shoham-A, "Cooperation Between Israeli and Foreign Researchers", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 381-400

Czech-I, "Current Issues in Serials Collection Development", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 235-236

Czech-I, "Marketing a New Social-Science Humanities Journal to Libraries, Then and Now", SERIALS LIBRARIAN,1991, Vol 21, Iss 2-3, pp 143-146

Czerwon-HJ Havemann-F, "Influence of Publication Languages on

the Citation Rate of Scientific Articles - A Case-Study of East German Journals", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 51-63

Dagg-AI, "Citation and Self-Respect", SCIENCE,1992, Vol 255, Iss 5041, pp 142-142

Dahl-M Lahlou-S, "Measurement of Network Effects from the EC Science Stimulation Programs", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 325-342

Dahlman-RC, "CO2 and Plants - Revisited", VEGETATIO,1993, Vol 104, Iss JAN, pp 339-355

Dalton-MS, "Refereeing of Scholarly Works for Primary Publishing", ANNUAL REVIEW OF INFORMATION SCIENCE AND TECHNOLOGY 1995, Vol 30, pp 213-250

Dame-MA Wolinsky-FD, "Reconciling Differences in Rating the Quality of Health-Care Administration Journals Between Program Chairs Perceptions and Citation Counts - Cutting Edge, Historical Seniority, Mainstream, Measurement Error, or Political Correctness", MEDICAL CARE,1994, Vol 32, Iss 6, pp 653-655

Dame-MA Wolinsky-FD, "Rating Journals in Health-Care Administration - The Use of Bibliometric Measures", MEDICAL CARE,1993, Vol 31, Iss 6, pp 520-524

Damiano-PC Shugars-DA Freed-JR, "Assessing Quality in Dentistry - Dental Boards, Peer-Review Vary on Disciplinary Actions", JOURNAL OF THE AMERICAN DENTAL ASSOCIATION,1993, Vol 124, Iss 5, pp 113+

Dan-AJ Pinsof-DA Riggs-LL, "Sexual Harassment as an Occupational Hazard in Nursing", BASIC AND APPLIED SOCIAL PSYCHOLOGY 1995, Vol 17, Iss 4, pp 563-580

Dancik-BP, "The Importance of Peer-Review", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 91-94

Daniel-HD, "An Evaluation of the Peer-Review Process at Angewandte-Chemie", ANGEWANDTE CHEMIE-INTERNATIONAL EDITION IN ENGLISH,1993, Vol 32, Iss 2, pp 234-238

Daniel-HD, "Concerning an Evaluation of the Peer-Review Process at Angewandte-Chemie - Reply", ANGEWANDTE CHEMIE-INTERNATIONAL EDITION IN ENGLISH,1993, Vol 32, Iss 7, pp 1030-1031

Dans-PE, "Clinical Peer-Review - Burnishing a Tarnished Icon", ANNALS OF INTERNAL MEDICINE,1993, Vol 118, Iss 7, pp 566-568

Darvill-AG Albersheim-P, "Studies of Phytoalexins and Their Elicitors Led to the Discovery of Oligosaccharins - A Citation-Classic Commentary on Phytoalexins and Their Elicitors - A Defense Against Microbial Infection in Plants by Darvill,A.G., Albersheim,P.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 32, pp 8-8

Dasen-PR, "How Ethnocentric Is Developmental-Psychology - A Citation-Classic on Cross-Cultural Piagetian Research - A Summary by Dasen,P.R.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 48, pp 8-8

DATABASE, "ISI Announces Citation-Indexes-for-Windows", DATABASE 1996, Vol 19, Iss 4, pp 78-78

Davenport-E, "Peerless Science - Peer-Review and United-States Science Policy, by D.E. Chubin, E.J. Hackett", JOURNAL OF DOCUMENTATION,1992, Vol 48, Iss 3, pp 336-338

Davenport-E, "Proceedings of the 5th Biennial Conference of the International-Society-for-Scientometrics-and-Informetrics, by M. Koenig, A. Bookstein", LIBRARY & INFORMATION SCIENCE RESEARCH 1996, Vol 18, Iss 1, pp 90-92

Davenport-E Snyder-H, "Who Cites Women - Whom Do Women Cite - An Exploration of Gender and Scholarly Citation in Sociology", JOURNAL OF DOCUMENTATION 1995, Vol 51, Iss 4, pp 404-410

Davidoff-AL Fogarty-L, "Psychogenic Origins of Multiple Chemical Sensitivities Syndrome - A Critical-Review of the Research Literature", ARCHIVES OF ENVIRONMENTAL HEALTH,1994, Vol 49, Iss 5, pp 316-325

Davies-MJ Fox-K Mills-P, "Speeding Up the Review Process", BRITISH HEART JOURNAL,1992, Vol 68, Iss 4, pp 345-345

Davila-J Mendoza-C Nunez-LA, "Productivity of Venezuelan Scientific-Research in Physics Measured on the Basis of Science-Citation-Index (Sci) 1979-1988", INTERCIENCIA,1991, Vol 16, Iss 4, pp 182-186

Davis-CH Cronin-B, "Acknowledgments and Intellectual Indebtedness - A Bibliometric Conjecture", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 10, pp 590-592

Davis-G Royle-P, "A Comparison of Australian University Output Using Journal Impact Factors", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 45-58

Davis-H, "The Effects of Communication/Counselling in Medical-Practice - An Evaluation", JOURNAL OF THE ROYAL SOCIETY OF MEDICINE,1994, Vol 87, Iss 7, pp 429-431

Davis-H Rushton-R, "Counseling and Supporting Parents of Children with Developmental Delay - A Research Evaluation", JOURNAL OF MENTAL DEFICIENCY RESEARCH,1991, Vol 35, Iss APR, pp 89-112

Davis-P, "Pharmaceuticals and Public-Policy - Learning from the New-Zealand Experience", HEALTH POLICY,1993, Vol 24, Iss 3, pp 259-272

Davoust-E Schmadel-LD, "A Study of the Publishing Activity of Astronomers Since 1969", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 9-39

Dearenas-JL, "Online Databases and Their Impact on Bibliometric Analysis - The Mexican Health-Sciences Research Case", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1993, Vol 18, Iss 1, pp 18-20

Dearenas-JL, "Partial Assessment of Mexican Health-Sciences Research 1982-1986", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 47-55

Dearenas-JL Valles-J Williams-D, "Bibliometrics and Agriculture - The Cuba Case", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1994, Vol 19, Iss 1, pp 13-15

Deathe-AB Helmes-E, "Evaluation of a Chronic Pain Program by Referring Physicians", PAIN,1993, Vol 52, Iss 1, pp 113-121

Debold-AJ, "The Discovery of Atrial-Natriuretic-Factor - A Citation-Classic Commentary on a Rapid and Potent Natriuretic Response to Intravenous-Injection of Atrial Myocardial Extract in Rats, by Debold,A.J., Borenstein,H.B., Veress,A.T., and Sonnenberg,H.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 26, pp 8-8

Debruin-RE Braam-RR Moed-HF, "Bibliometric Lines in the Sand", NATURE,1991, Vol 349, Iss 6310, pp 559-562

Debruin-RE Moed-HF, "Delimitation of Scientific Subfields Using

Cognitive Words from Corporate Addresses in Scientific Publications", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 65-80

Declercq-NG Lund-J, "Back Injuries, OSHA General Duty Clause Citations, and the NIOSH Lifting Guidelines", LABOR LAW JOURNAL,1991, Vol 42, Iss 12, pp 807-813

Dehaan-J Leeuw-FL Remery-C, "Accumulation of Advantage and Disadvantage in Research Groups", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 239-251

Dejong-JW Schaper-W, "The International Rank Order of Clinical Cardiology", EUROPEAN HEART JOURNAL 1996, Vol 17, Iss 1, pp 35-42

Delamothe-J, "The Revision of International Science Indicators - The Frascati Manual", TECHNOLOGY IN SOCIETY,1992, Vol 14, Iss 4, pp 427-440

Delany-E, "Strategy Consultants - Do They Add Value", LONG RANGE PLANNING 1995, Vol 28, Iss 6, pp 99-106

Delcomyn-F, "Peer-Review - Explicit Criteria and Training Can Help", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 144-144

Delgado-EA Howard-GS, "Changes in Research Productivity in Counseling Psychology - Revisiting Howard (1983) a Decade Later", JOURNAL OF COUNSELING PSYCHOLOGY,1994, Vol 41, Iss 1, pp 69-73

Delgado-H Russell-JM, "Impact of Studies Published in the International Literature by Scientists at the National-University-of-Mexico", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 75-90

Dellaringa-C Lucifora-C, "Wage Dispersion and Unionism - Do Unions Protect Low Pay", INTERNATIONAL JOURNAL OF MANPOWER,1994, Vol 15, Iss 2-3, pp 150-169

Delooze-MA, "Scientometrics as a Tool for Analysis of the Industrial Relationships of 2 Departments in a Major French Applied-Research Institute, 1988-1992", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 349-360

Delooze-MA, "The Application of Scientometric Tools to the Analysis of a Sector in Plant Biotechnologies - Nitrogen-Fixation", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 23-34

Delooze-MA Coronini-R Legentil-M Jeannin-P Magri-MH, "Determining the Core of Journals of a Research-Center - The Example of Researchers from the Department of Rural Economy and Sociology of the Institut-National-de-La-Recherche-Agronomique, France", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 167-183

Demeis-L Machado-RDP Fonseca-L Lustosa-P Caldeira-MT, "Scientometrics and Peer Evaluation", INTERCIENCIA,1992, Vol 17, Iss 1, pp 40-43

Denchev-S, "Science and Technology in the New Bulgaria", TECHNOLOGY IN SOCIETY,1993, Vol 15, Iss 1, pp 57-63

Denwood-R, "Data Capture for Quality Management Nursing Opportunity", COMPUTERS IN NURSING 1996, Vol 14, Iss 1, pp 39-44

Deriemer-C, "A Survey of Vu/Text Use in the Newsroom", JOURNALISM QUARTERLY,1992, Vol 69, Iss 4, pp 960-970

Desantis-P, "Conformational Energy Calculations of Macromolecules - A Citation-Classic Commentary on Stability of Helical Conformations of Simple Linear by Desantis,P., Giglio,E., Liquori,A.M., and Ripamonti,A.", CURRENT CONTENTS/PHYSICAL CHEMICAL

& EARTH SCIENCES,1992, Iss 34, pp 8-8

Desmet-E, "Information Behavior in a Scientific-Technical Environment - A Survey with Innovation Engineers", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 101-113

Dewardener-HE Macgregor-GA, "Essential-Hypertension, Kidney, Sodium - A Hypothesis - A Citation-Classic Commentary on Dahl Hypothesis That a Saluretic Substance May Be Responsible for a Sustained Rise in Arterial-Pressure - Its Possible Role in Essential-Hypertension by Dewardener,H.E., Macgregor,G.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 12, pp 8-8

Diamond-AM Haurin-DR, "The Dissemination of Research Agendas Among Young Economists", JOURNAL OF ECONOMIC EDUCATION,1993, Vol 24, Iss 1, pp 53-61

Diamond-AM Levy-DM, "The Metrics of Style - Smith,Adam Teaches Efficient Rhetoric", ECONOMIC INQUIRY,1994, Vol 32, Iss 1, pp 138-145

Dickenson-RP, "The Level of Research in Advanced Composite-Materials in the Countries of the Former Soviet-Union", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 43-57

Dickey-DA, "A Statistical Test for Stability - A Citation-Classic Commentary on Likelihood Ratio Statistics for Autoregressive Time-Series with a Unit-Root by Dickey,D.A., Fuller,W.A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 44, pp 8-8

Dickey-LL, "Promoting Preventive Care with Patient-Held Minirecords -A Review", PATIENT EDUCATION AND COUNSELING,1993, Vol 20, Iss 1, pp 37-47

Dickman-S, "Peer-Review in the Czech Republic - Response", SCIENCE,1993, Vol 262, Iss 5137, pp 1193-1194

Dickson-D, "British Research Council Seeks to Cut Role of Collective Peer-Review", NATURE,1994, Vol 368, Iss 6467, pp 85-86

Dickson-D, "Peer-Review - NIH Urged to Streamline Bids ... as Britain Seeks to Reassure Doubters over Policy Changes", NATURE,1994, Vol 370, Iss 6486, pp 170-171

Dickson-D, "Peer-Review - A Call for Help", NATURE,1994, Vol 372, Iss 6507, pp 597-597

Dierick-JCJ, "Determining the Lotka Parameters by Sampling", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 115-148

Dietz-JR, "Release of Atrial-Natriuretic-Factor (ANF) by Atrial Distension - A Citation-Classic Commentary on Release of Natriuretic Factor from a Rat Heart-Lung Preparation by Atrial Distension by Dietz,J.R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 38, pp 9-9

Dietz-JR, "Release of Atrial-Natriuretic-Factor (ANF) by Atrial Distension - A Citation-Classic Commentary on Release of Natriuretic Factor from a Rat Heart-Lung Preparation by Atrial Distension by Dietz,J.R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 38, pp 9-9

Dietz-RS, "Barringer Medal Citation for Masaitis,Victor,L. - 25 July ,1991 Monterey, California USA", METEORITICS,1992, Vol 27, Iss 1, pp 19-20

Dillabough-JA Mcalpine-L, "Rethinking Research Processes and Praxis in the Social-Studies - The Cultural Politics of Methodology in Text Evaluation Research", THEORY AND RESEARCH IN SOCIAL EDUCATION 1996, Vol 24, Iss 2, pp 167-203

Dillon-C Gunawardena-C, "Evaluation Research in Distance Education", BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY,1992, Vol 23, Iss 3, pp 181-194

Dimitroff-A Arlitsch-K, "Self-Citations in the Library and Information-Science Literature", JOURNAL OF DOCUMENTATION,1995, Vol 51, Iss 1, pp 44-56

Dinarello-CA, "The Interleukin-1 Controversy - A Citation-Classic Commentary on Interleukin-1 by Dinarello,C.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 50, pp 8-8

Dinarello-CA Webb-AC Rosenwasser-LJ Rich-A Wolff-SM Auron-PE, "Molecular-Cloning of Human Interleukin-1B - A Citation-Classic Commentary on Nucleotide-Sequence of Human Monocyte Interleukin-1 Precursor cDNA by Auron,P.E., Webb,A.C., Rosenwasser,L.J., Mucci,S.F., Rich,A., Wolff,S.M., and Dinarello,C.A.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 51-52, pp 8-8

Diodato-V Smith-F, "Obsolescence of Music Literature", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 2, pp 101-112

Dirk-L, "From Laboratory to Scientific Literature - The Life and Death of Biomedical-Research Results", SCIENCE COMMUNICATION 1996, Vol 18, Iss 1, pp 3-28

Dixon-B, "Citation Analysis and HIV", BIO-TECHNOLOGY,1994, Vol 12, Iss 11, pp 1050-1050

Dixon-B, "The Grossest Failures of Peer-Review", BRITISH MEDICAL JOURNAL,1993, Vol 307, Iss 6896, pp 137-137

Dizon-LB Sadorra-MSM, "Patterns of Publication by the Staff of an International Fisheries Research-Center", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 67-75

Dole-WV Chang-SS, "Survey and Analysis of Demand for Journals at the State-University of New-York at Stony-Brook", LIBRARY ACQUISITIONS-PRACTICE AND THEORY 1996, Vol 20, Iss 1, pp 23-38

Dolinsky-D, "Teaching Skills of Research Evaluation", AMERICAN JOURNAL OF PHARMACEUTICAL EDUCATION,1994, Vol 58, Iss 1, pp 82-86

Dolton-PJ, "Economies of Atmosphere - The Joint Impact of Scale, Scope and Atmosphere on Scientific Performance in Clinical Medicine and Economics, by J.F.A. Spangenberg", JOURNAL OF ECONOMIC PSYCHOLOGY,1991, Vol 12, Iss 2, pp 407-409

Donaldson-LJ Cresswell-PA, "Dissemination of the Work of Public-Health Medicine Trainees in Peer-Reviewed Publications - An Unfulfilled Potential", PUBLIC HEALTH 1996, Vol 110, Iss 1, pp 61-63

Donleavy-GD, "Evaluating the Potential of Office Robotics", LONG RANGE PLANNING,1994, Vol 27, Iss 2, pp 119-127

Dorban-M Vandevenne-AF, "Bibliometric Analysis of Bibliographic Behaviors in Economic Sciences", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 149-165

Dore-JC Ojasoo-T Okubo-Y Durand-T Dudognon-G Miquel-JF, "Correspondence Factor-Analysis of the Publication Patterns of 48 Countries over the Period 1981-1992", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 8, pp 588-602

Doreian-P, "A Measure of Standing for Citation Networks Within a Wider Environment", INFORMATION PROCESSING & MANAGEMENT,1994, Vol

30, Iss 1, pp 21-31

Dou-H, "In Which Business Are We", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 401-406

Dou-H Quoniam-L Hassanaly-P, "The Scientific Dynamics of a City - A Study of Chemistry in Marseilles from 1981 to the Present", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 83-93

Douthitt-R, ",1992 Distinguished Fellow of the American-Council-on-Consumer-Interests - Goebel,Karen,P. - Citation", JOURNAL OF CONSUMER AFFAIRS,1992, Vol 26, Iss 2, pp 219-220

Downward-J, "Oncogene Encodes EGF Receptor - A Citation-Classic Commentary on Close Similarity of Epidermal Growth-Factor Receptor and V-Erb-B Oncogene Protein Sequences by Downward,J., Yarden,Y., Mayes,E., Scrace,G., Totty,N., Stockwell,P., Ullrich,A., Schlessinger,J. and Waterfield,M.D.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 34, pp 8-8

Dowton-M, "Citation Policy on Sequences", NATURE 1996, Vol 381, Iss 6583, pp 550-550

Doyle-JR Arthurs-AJ Green-RH Mcaulay-L Pitt-MR Bottomley-PA, "The Judge, the Model of the Judge, and the Model of the Judged as Judge - Analyses of the UK 1992 Research Assessment Exercise Data for Business and Management Studies", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 1, pp 13-28

Doyle-JR Arthurs-AJ Mcaulay-L Osborne-PG, "Citation as Effortful Voting - A Reply", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 5, pp 603-606

Draaijers-GPJ Vanek-R Meijers-R, "Research on the Impact of Forest Stand Structure on Atmospheric Deposition", ENVIRONMENTAL POLLUTION,1992, Vol 75, Iss 2, pp 243-249

Dracup-K Baker-DW Dunbar-SB Dacey-RA Brooks-NH Johnson-JC Oken-C Massie-BM, "Management of Heart-Failure .2. Counseling, Education, and Life-Style Modifications", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 18, pp 1442-1446

Draugalis-JR Slack-MK, "A Course Model for Teaching-Research Evaluation in Colleges of Pharmacy", AMERICAN JOURNAL OF PHARMACEUTICAL EDUCATION,1992, Vol 56, Iss 1, pp 48-52

Drinka-TJK, "Applying Learning from Self-Directed Work Teams in Business to Curriculum-Development for Interdisciplinary Geriatric Teams", EDUCATIONAL GERONTOLOGY 1996, Vol 22, Iss 5, pp 433-450

Driver-C Saw-CW, "Performance of Structural-Change Indexes - Analysis Using Real and Simulated Data", APPLIED ECONOMICS LETTERS 1996, Vol 3, Iss 3, pp 187-188

Drosler-J, "Peer-Review and Majority-Rule", ZEITSCHRIFT FUR EXPERIMENTELLE UND ANGEWANDTE PSYCHOLOGIE,1992, Vol 39, Iss 1, pp R3-R5

Drummond-MF Jefferson-TO, "Guidelines for Authors and Peer Reviewers of Economic Submissions to the Bmj", BRITISH MEDICAL JOURNAL 1996, Vol 313, Iss 7052, pp 275-283

Dubin-D Hafner-AW Arndt-KA, "Citation-Classics in Clinical Dermatological Journals - Citation Analysis, Biomedical Journals, and Landmark Articles, 1945-1990", ARCHIVES OF DERMATOLOGY,1993, Vol 129, Iss 9, pp 1121-1129

Dubner-R, "Neural Basis of Oral-Facial Function and Pain a Citation-Classic Commentary on the Neural Basis of Oral and Facial Function by Dubner,R., Sessle,B.J., and Storey,A.T. and Neurons That Subserve the Sensory-Discriminative Aspects of Pain by Price,D.D., and Dubner,R.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 12, pp 8-8

Duggan-MK, "Naturalistic Inquiry for Library-Science - Methods and Applications for Research, Evaluation, and Teaching, by C.A. Mellon", LIBRARY & INFORMATION SCIENCE RESEARCH1990, Vol 12, Iss 4, pp 436-437

Dumas-T Logan-E Finley-A, "In Focus - Using Citation Analysis and Subject Classification to Identify and Monitor Trends Within a Discipline", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 135-150

Duncan-NC, "Evaluation of Instructional Software - Design Considerations and Recommendations", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS,1993, Vol 25, Iss 2, pp 223-227

Dunlap-G Kern-L, "Modifying Instructional Activities to Promote Desirable Behavior - A Conceptual and Practical Framework", SCHOOL PSYCHOLOGY QUARTERLY 1996, Vol 11, Iss 4, pp 297-312

Dunn-DS, "Collaborative Writing in a Statistics and Research Methods Course", TEACHING OF PSYCHOLOGY 1996, Vol 23, Iss 1, pp 38-40

Dunn-K Chisnell-C Szak-S Sittig-DF, "A Quantitative Method for Measuring Library User Journal Needs - A Pilot-Study Using Cd Plus Medline Usage Statistics", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Iss S, pp 108-112

Duplenko-YK Burchinskii-SG, "Method of Computer Citation Cluster-Analysis as the Tool of Detection and Research of the Structure of Scientific Trends", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 1-ORGANIZATSIYA I METODIKA INFORMATSIONNOI RABOTY,1993, Iss 4, pp 20-24

Duplenko-YK Burchinsky-SG, "Computer Cluster-Analysis of Citation as a Tool in the Study of the Structure of a Scientific Trend", VESTNIK ROSSIISKOI AKADEMII MEDITSINSKIKH NAUK,1992, Iss 8, pp 60-64

Duplenko-YK Burchinsky-SG, "Interdisciplinary Research in Gerontology - Citation Analysis", FIZIOLOGICHESKII ZHURNAL,1991, Vol 37, Iss 1, pp 114-117

Duplenko-YK Burchinsky-SG, "Interdisciplinary Research in Gerontology - Citation Analysis", FIZIOLOGICHESKII ZHURNAL,1991, Vol 37, Iss 1, pp 114-117

Duplenko-YK Burchinsky-SG, "Computerized Cluster-Analysis of Citation Networks - Methodology and Use in Research Policy Formulation", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1993, Vol 18, Iss 3-4, pp 10-13

Durant-RH, "Checklist for the Evaluation of Research Articles", JOURNAL OF ADOLESCENT HEALTH,1994, Vol 15, Iss 1, pp 4-8

Durno-D, "Involvement of Lay Visitors in General-Practice Assessment Visits", BRITISH JOURNAL OF GENERAL PRACTICE,1992, Vol 42, Iss 362, pp 387-389

Durrington-PN Laker-MF Keech-A, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 420-421

Durso-TW, "Researchers Disagree on NIH Plan to Improve Its Peer-Review Process", SCIENTIST 1996, Vol 10, Iss 24, pp 1+

Dyer-CB Ashton-CM Teasdale-TA, "Postoperative Delirium - A Review of 80 Primary Data-Collection Studies", ARCHIVES OF INTERNAL MEDICINE,1995, Vol 155, Iss 5, pp 461-465

Dykeman-A, "Faculty Citations - An Approach to Assessing the Impact of Diminishing Resources on Scientific-Research", LIBRARY ACQUISITIONS-PRACTICE AND THEORY,1994, Vol 18, Iss 2, pp 137-146

Dyken-ML, "Evolution, Not Revolution", STROKE,1992, Vol 23, Iss 1, pp 1-2

DYNAM-PSYCH, "International-Expert-Commission Evaluates the Research Activities of the Central-Institute-for-Mental-Health - Outstanding Institution for Research in Clinical-Psychiatry", DYNAMISCHE PSYCHIATRIE,1993, Vol 26, Iss 5-6, pp 477-478

Dyson-AH, "The Case of the Singing Scientist - A Performance Perspective on the Stages of School Literacy", WRITTEN COMMUNICATION,1992, Vol 9, Iss 1, pp 3-47

Ebihara-K, "Tracking the Specialties and Development of Research Using Cocitation Maps and Citation Diagrams - The Outline of Representation of Knowledge Study in Psychology", LIBRARY AND INFORMATION SCIENCE,1993, Iss 31, pp 95-126

Eden-B Griliches-Z, "Productivity, Market Power, and Capacity Utilization When Spot Markets Are Complete", AMERICAN ECONOMIC REVIEW,1993, Vol 83, Iss 2, pp 219-223

Edward-JT, "Be Cited or Perish", CHEMTECH,1992, Vol 22, Iss 9, pp 534-539

Edwards-RA Edwards-KJ, "Multiple Authorship and Citation Analysis", SCOTTISH GEOGRAPHICAL MAGAZINE 1995, Vol 111, Iss 3, pp 168-171

Efremenkova-VM Milovidov-N, "The Data Structure of the VINITI Computer-Networks Information File", KNOWLEDGE ORGANIZATION,1993, Vol 20, Iss 4, pp 208-209

Egghe-L, "A Theory of Continuous Rates and Applications to the Theory of Growth and Obsolescence Rates", INFORMATION PROCESSING & MANAGEMENT,1994, Vol 30, Iss 2, pp 279-292

Egghe-L, "Bridging the Gaps - Conceptual Discussions on Informetrics", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 35-47

Egghe-L, "Generalized Transfer Principles in Econometrics and Informetrics", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 167-191

Egghe-L, "Little Science, Big Science ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 389-392

Egghe-L, "On the Influence of Growth on Obsolescence", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 195-214

Egghe-L, "The Exact Place of Zipfs and Paretos Law Amongst the Classical Informetric Laws", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 93-106

Egghe-L Rao-IKR, "Citation Age Data and the Obsolescence Function - Fits and Explantations", INFORMATION PROCESSING & MANAGEMENT,1992, Vol 28, Iss 2, pp 201-217

Egghe-L Rao-IKR, "Classification of Growth-Models Based on Growth-Rates and Its Applications", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 5-46

Egghe-L Rousseau-R, "Average and Global Impact of a Set of Journals", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 97-107

Egghe-L Rousseau-R, "Averaging and Globalising Quotients of Informetric and Scientometric Data", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 3, pp 165-170

Ehlen-CR Welker-RB, "Procedural Fairness in the Peer and Quality Review Programs", AUDITING-A JOURNAL OF PRACTICE & THEORY 1996, Vol 15, Iss 1, pp 38-52

Eibeck-P, "Criteria for Peer-Review of Engineering Courseware on the Needs Database", IEEE TRANSACTIONS ON EDUCATION 1996, Vol 39, Iss 3, pp 381-387

Eid-M Emmermann-A Schwenkmezger-P, "Are the Experience and Expression of Anger Universal Constructs - Results of the Analysis of the State-Trait Anger Expression Inventory with Logistic Mixture Distribution Models", DIAGNOSTICA 1996, Vol 42, Iss 1, pp 3-26

Elalami-J Dore-JC Miquel-JF, "International Scientific Collaboration in Arab Countries", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 249-263

Elcock-H, "How Organizations Measure Success - The Use of Performance Indicators in Governments, by R. Klein, P. Day", PARLIAMENTARY AFFAIRS,1992, Vol 45, Iss 3, pp 444-447

Elferinkstinkens-PM Brand-R Lecessie-S Vanhemel-OJS, "Large Differences in Obstetrical Intervention Rates Among Dutch Hospitals, Even After Adjustment for Population Differences", EUROPEAN JOURNAL OF OBSTETRICS GYNECOLOGY AND REPRODUCTIVE BIOLOGY 1996, Vol 68, Iss 1-2, pp 97-103

Elferinkstinkens-PM Vanhemel-OJS Hermans-MPM, "Obstetric Characteristics Profiles as Quality Assessment of Obstetric Care", EUROPEAN JOURNAL OF OBSTETRICS GYNECOLOGY AND REPRODUCTIVE BIOLOGY,1993, Vol 51, Iss 2, pp 85-90

Elkin-J Law-D, "Research Assessment Exercise ,1992 - Library and Information Management and Communications and Media Studies Panel", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1994, Vol 26, Iss 3, pp 141-147

Ellis-AE, "Cells of the Fish Immune-System - A Citation-Classic Commentary on the Leukocytes of Fish - A Review by Ellis,A.E.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 30, pp 10-10

Ellis-AE, "Cells of the Fish Immune-System - A Citation-Classic Commentary on the Leukocytes of Fish - A Review by Ellis,A.E.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 30, pp 10-10

Ellis-D, "Qualitative Evaluation and Research Methods, 2nd Edition, by M.Q. Patton", INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT1990, Vol 10, Iss 4, pp 323-323

Elsworth-GR, "Arguing Challenges to Validity in-Field Research - A Realist Perspective", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1994, Vol 15, Iss 3, pp 321-343

Elsworth-GR, "Confronting the Biases in Connoisseur Review and Performance Indicators in Higher-Education - A Structural Modeling Approach", HIGHER EDUCATION,1994, Vol 27, Iss 2, pp 163-190

Emery-JA Meyers-HW Hunter-DE, "NIH 1st Awards - Testing

Background Factors for Funding Against Peer-Review", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS,1992, Vol 24, Iss 2, pp 7-28

Emery-RE, "A Decade of Interparental Conflict - A Citation-Classic Commentary on Interparental Conflict and the Children of Discord and Divorce by Emery,R.E.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 16, pp 8-8

Emiliani-C, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 184-184

Emsley-J, "Citation Analysis Reveals Organic-Chemistry Most Active Research (Reprinted from Science-Watch, Vol 4, Pg 7, ,1993)", SCIENTIST,1994, Vol 8, Iss 5, pp 15-15

Emsley-J, "So Far, Fullerene Studies Dominate Chemical Citations in the 1990s (Reprinted from Science Watch, July August, ,1994)", SCIENTIST,1994, Vol 8, Iss 21, pp 14-15

Engelsman-EC Vanraan-AFJ, "A Patent-Based Cartography of Technology", RESEARCH POLICY,1994, Vol 23, Iss 1, pp 1-26

Engle-RF, "Arch - A Citation-Classic Commentary on Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United-Kingdom Inflation by Engle,R.F.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 38, pp 8-8

Engle-RF Granger-CWJ, "Cointegration - The Early Days - A Citation-Classic Commentary on Cointegration and Error Correction - Representation, Estimation, and Testing by Engle,R.F. and Granger,C.W.J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 2, pp 8-8

Englisch-H, "Monotonous Structure Measures for Social-Groups", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 159-169

Entwistle-V, "Reporting Research in Medical Journals and Newspapers", BRITISH MEDICAL JOURNAL,1995, Vol 310, Iss 6984, pp 920-923

Eom-SB, "Mapping the Intellectual Structure of Research in Decision-Support Systems Through Author Cocitation Analysis (1971-1993)", DECISION SUPPORT SYSTEMS 1996, Vol 16, Iss 4, pp 315-338

Eom-SB, "Ranking Institutional Contributions to Decision-Support Systems Research - A Citation Analysis", DATA BASE,1994, Vol 25, Iss 1, pp 35-42

Eom-SB Farris-RS, "The Contributions of Organizational Science to the Development of Decision-Support Systems Research Subspecialties", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 12, pp 941-952

Eom-SB Lee-SM, "Leading United-States Universities and Most Influential Contributors in Decision Support Systems Research (1971-1989) - A Citation Analysis", DECISION SUPPORT SYSTEMS,1993, Vol 9, Iss 3, pp 237-244

Eom-SB Lee-SM Kim-JK, "The Intellectual Structure of Decision-Support Systems (1971-1989)", DECISION SUPPORT SYSTEMS,1993, Vol 10, Iss 1, pp 19-35

Epstein-BH Kaufman-A, "Hospital Peer-Review - A New Proposal", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 271, Iss 19, pp 1485-1485

Epstein-RJ, "6 Authors in Search of a Citation - Villains or

Victims of the Vancouver Convention", BRITISH MEDICAL JOURNAL,1993, Vol 306, Iss 6880, pp 765-767

Erhard-GD, "The Peer-Review Masquerade - Disguising Health-Care Rationing Under the Pennsylvania Auto Insurance Law", UNIVERSITY OF PITTSBURGH LAW REVIEW 1996, Vol 57, Iss 4, pp 959-982

Erickson-RO, "How Does Your Garden Grow - A Citation-Classic Commentary on the Plastochron Index by Erickson,R.O. and Michelini,F.J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 6, pp 10-10

Eriksson-DM, "Organization Information-System - Extending Organizational Cognition Through Intelligent Artifacts", CYBERNETICS AND SYSTEMS 1996, Vol 27, Iss 3, pp 235-263

Ernst-E, "Criticizing the Critics - Is Peer-Reviewing Fair", JOURNAL OF CLINICAL EPIDEMIOLOGY,1994, Vol 47, Iss 7, pp 817-818

Ernst-E Resch-KL, "Reviewer Bias - A Blinded Experimental-Study", JOURNAL OF LABORATORY AND CLINICAL MEDICINE,1994, Vol 124, Iss 2, pp 178-182

Ernst-E Saradeth-T Resch-KL, "Drawbacks of Peer-Review", NATURE,1993, Vol 363, Iss 6427, pp 296-296

Eron-LD, "Benton,Arthur - Citation", AMERICAN PSYCHOLOGIST,1992, Vol 47, Iss 7, pp 851-853

EST, "Ord to Establish Peer-Review Advisory Panel", ENVIRONMENTAL SCIENCE & TECHNOLOGY 1996, Vol 30, Iss 8, pp A327-A328

Estes-JR, "The National-Science-Foundation - Financial, Intellectual, and Knowledge Broker for Systematic Biology", ANNALS OF THE MISSOURI BOTANICAL GARDEN,1993, Vol 80, Iss 2, pp 323-332

Eto-H, "Quality Assessment of Science Information Research and Service", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 429-432

Eto-H, "Science Revolution and Ortega Hypothesis in Developing-Countries", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 283-295

Evans-M, "Peer-Review", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 5, pp 4-4

Everett-B Boydell-K, "A Methodology for Including Consumers Opinions in Mental-Health Evaluation Research", HOSPITAL AND COMMUNITY PSYCHIATRY,1994, Vol 45, Iss 1, pp 76-78

Everett-B Boydell-K, "A Methodology for Including Consumers Opinions in Mental-Health Evaluation Research", HOSPITAL AND COMMUNITY PSYCHIATRY,1994, Vol 45, Iss 1, pp 76-78

Everett-JE, "The Journal Relations of Human-Relations", HUMAN RELATIONS,1994, Vol 47, Iss 1, pp 1-12

Everett-JE, "The Validity of Poisson Assumptions in a Combined Loglinear MDs Mapping Model", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 3, pp 175-178

Everett-JE Pecotich-A, "Citation Analysis Mapping of Journals in Applied and Clinical-Psychology", JOURNAL OF APPLIED SOCIAL PSYCHOLOGY,1993, Vol 23, Iss 9, pp 750-766

Everett-JE Pecotich-A, "A Combined Loglinear MDs Model for Mapping Journals by Citation Analysis", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 6, pp 405-413

Exner-O, "Scientometrics, Impact Factor, Citation Analysis - An Extremely Critical-View", CHEMICKE LISTY,1993, Vol 87, Iss 10, pp 719-728

Exner-O, "Scientometrics, Impact Factor, Citation Analysis - An Extremely Critical-View (Vol 87, Pg 719, ,1993)", CHEMICKE LISTY,1993, Vol 87, Iss 12, pp 888-888

Exner-O Kunz-M, "Citation Histories of Related Papers in the Field of Chemical Correlation-Analysis", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 3-10

Eyers-K Brodaty-H Roy-K, "What the Doctor Ordered - Referrer Satisfaction with a Mood Disorders Unit", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY,1994, Vol 28, Iss 3, pp 498-504

Eykhoff-P, "System-Identification - Uncertainty as an Assignment - A Citation-Classic Commentary on System-Identification - Parameter and State Estimation by Eykhoff,P.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 51-52, pp 10-10

Eysenck-HJ Eysenck-SBG, "Peer-Review - Advice to Referees and Contributors", PERSONALITY AND INDIVIDUAL DIFFERENCES,1992, Vol 13, Iss 4, pp 393-399

Eysenck-HJ Eysenck-SBG, "6 Months of Peer Reviewing", PERSONALITY AND INDIVIDUAL DIFFERENCES,1994, Vol 17, Iss 4, pp 453-453

Faber-B, "Rhetoric in Competition - The Formation of Organizational Discourse in Conference on College Composition and Communication Abstracts", WRITTEN COMMUNICATION 1996, Vol 13, Iss 3, pp 355-384

Fagerhol-MK Abildgaard-U, "The Dominant Thrombin Inhibitor - A Citation-Classic Commentary on Immunological Studies on Human Antithrombin .3. Influence of Age, Sex and Use of Oral-Contraceptives on Serum Concentration", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 8, pp 8-8

Fahey-PP Gibberd-RW, "Monitoring Postoperative Pulmonary Embolisms in Australia .1. Variation Between Hospitals", INTERNATIONAL JOURNAL FOR QUALITY IN HEALTH CARE 1995, Vol 7, Iss 4, pp 373-380

Faigman-DL, "The Evidentiary Status of Social-Science Under Daubert - Is It Scientific, Technical, or Other Knowledge", PSYCHOLOGY PUBLIC POLICY AND LAW 1995, Vol 1, Iss 4, pp 960-979

Fairbairn-B, "The Present and Future of Historical Journals", JOURNAL OF SCHOLARLY PUBLISHING 1996, Vol 27, Iss 2, pp 59-74

Faller-KC, "Family Sexual Abuse - Frontline Research and Evaluation, by M.Q. Patton", CHILD ABUSE & NEGLECT,1992, Vol 16, Iss 4, pp 621-622

Fang-PH Fang-JM, "A Modification of Lotka Function for Scientific Productivity", INFORMATION PROCESSING & MANAGEMENT,1995, Vol 31, Iss 1, pp 133-137

Farde-L, "The Advantage of Using Positron Emission Tomography in Drug Research", TRENDS IN NEUROSCIENCES 1996, Vol 19, Iss 6, pp 211-214

Fare-R Grosskopf-S Tyteca-D, "An Activity Analysis Model of the Environmental Performance of Firms - Application to Fossil-Fuel-Fired Electric Utilities", ECOLOGICAL ECONOMICS 1996, Vol 18, Iss 2, pp 161-175

Farias-RN Bloj-B Trucco-RE, "Membrane-Bound Enzyme Regulation - A Citation-Classic Commentary on Regulation of Allosteric

Membrane-Bound Enzymes Through Changes in Membrane Lipid-Composition by Farias,R.N., Bloj,B., Morero,R.D., Sineriz,F. and Trucco,R.E.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 2, pp 8-8

Farkas-E, "Microtitrations in Serology and Virology - A Citation-Classic Commentary on the Use of Spiral Loops in Serological and Virological Micro-Methods by Takatsy,G.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 30, pp 10-10

Farren-EA, "Doctoral Preparation and Research Productivity", NURSING OUTLOOK,1991, Vol 39, Iss 1, pp 22-25

Farrington-DP, "Quantitative Criminology in the United-Kingdom in the 1990s - A Brief Overview", JOURNAL OF QUANTITATIVE CRIMINOLOGY 1996, Vol 12, Iss 3, pp 249-263

Fasman-GD, "Poly-Alpha-Amino Acids - A Citation-Classic Commentary on Protein Models for Conformational Studies by Fasman,G.D.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 18, pp 10-10

Fauchald-K, "Diet of Worms - A Citation-Classic Commentary on the Diet of Worms - A Study of Polychaete Feeding Guilds by Fauchald,K., and Jumars,P.A.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 40, pp 8-8

Feinberg-AP, "DNA Labeling by Random Printing - A Citation-Classic Commentary on a Technique for Radiolabeling DNA Restriction Endonuclease Fragments to High Specific Activity by Feinberg,A.P., and Vogelstein,B., and Addendum by Vogelstein,B.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 18, pp 8-8

Feinstein-AR, "Construction, Consent, and Condemnation in Research on Peer-Review", JOURNAL OF CLINICAL EPIDEMIOLOGY,1991, Vol 44, Iss 4-5, pp 339-341

Feizi-T, "Roles for Oligosaccharides in Biology and Medicine - A Citation-Classic Commentary on Demonstration byMonoclonal-Antibodies That Carbohydrate Structures of Glycoproteins and Glycolipids Are Oncodevelopmental Antigens by Feizi,T.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 30, pp 8-8

Feldman-MD Feldman-JM, "Tangled in the Web - Countertransference in the Therapy of Factitious Disorders", INTERNATIONAL JOURNAL OF PSYCHIATRY IN MEDICINE 1995, Vol 25, Iss 4, pp 389-399

Felleisen-R Gottstein-B, "Arbitrarily Primed PCR - Research Benefits from Arbitrariness", SCHWEIZER ARCHIV FUR TIERHEILKUNDE 1996, Vol 138, Iss 3, pp 139-143

Fellgett-PB, "A Note on Citations to Papers by British Astronomers", QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY,1994, Vol 35, Iss 3, pp 351-352

Fenner-DB Lerch-FJ Kulik-CT, "The Impact of Computerized Performance Monitoring and Prior Performance Knowledge on Performance Evaluation", JOURNAL OF APPLIED SOCIAL PSYCHOLOGY,1993, Vol 23, Iss 7, pp 573-601

Fenske-RE Dalrymple-PW, "Factors Influencing Research Productivity Among Health-Sciences Librarians", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1992, Vol 80, Iss 4, pp 353-360

Fergusonsmith-MA, "Active X and Y Homologous Genes - A Citation-Classic Commentary on Karyotype-Phenotype Correlations in Gonadal-Dysgenesis and Their Bearing on the Pathogenesis of

Malformations by Fergusonsmith,M.A.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 20, pp 10-10

Fernandez-MT Agis-A Martin-A Cabrero-A Gomez-I, "Cooperative Research Projects Between the Spanish-National-Research-Council and Latin-American Institutions", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 137-148

Fernstrom-JD, "Searching for a Dietary Connection to Neurotransmitters -A Citation-Classic Commentary on Brain-Serotonin Content - Physiological Dependence on Plasma Tryptophan Levels - Brain-Serotonin Content - Increase Following Ingestion of Carbohydrate-Diet - And Brain-Serotonin Content - Physiological Regulation by Plasma Neutral Amino-Acids by Fernstrom,J.D., and Wurtman,R.J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 32, pp 11-12

Ferreiro-L Ugena-S, "Citation Mechanics in Journals Covered by the Journal Citation Reports", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 149-162

Ferrell-B, "Peer-Reviewed Letters", JOURNAL OF FORESTRY,1992, Vol 90, Iss 12, pp 4-4

Feurer-ID Becker-GJ Picus-D Ramirez-E Darcy-MD Hicks-ME, "Evaluating Peer Reviews - Pilot Testing of a Grading Instrument", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 98-100

Fidel-R, "Naturalistic Inquiry for Library-Science - Methods and Applications for Research, Evaluation, and Teaching, by C.A. Mellon", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 4, pp 523-524

Fielder-JH, "Disposable Doctors - Incentives to Abuse Physician Peer-Review", JOURNAL OF CLINICAL ETHICS 1995, Vol 6, Iss 4, pp 327-332

Fielding-N, "Bias in Criminological Research", JOURNAL OF FORENSIC PSYCHIATRY 1996, Vol 7, Iss 1, pp 5-14

Fields-HL, "Painless Pain - A Citation-Classic Commentary on Brain-Stem Control of Spinal Pain Transmission Neurons by Fields,H.L. and Basbaum,A.I.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 22, pp 10-10

Fine-MA, "Reflections on Enhancing Accountability in the Peer-Review Process", AMERICAN PSYCHOLOGIST 1996, Vol 51, Iss 11, pp 1190-1191

Finlan-JK Zibrat-FS, "Struggles and Successes - Experiences of a Beta-Test Site", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT,1994, Vol 20, Iss 2, pp 49-56

Fins-JJ, "Praxis Makes Perfect", HASTINGS CENTER REPORT,1993, Vol 23, Iss 5, pp 16-19

Fiore-MC Wetter-DW Bailey-WC Bennett-G Cohen-SJ Dorfman-SF Goldstein-MG Gritz-ER Hasselblad-V Henningfield-JE Heyman-RB Holbrook-J Husten-C Jaen-CR Kohler-C Kottke-TE Lando-HA Manley-M Mecklenburg-R Melvin-C Mullen-PD Nett-LM Piasecki-TM Robinson-L Rothstein-D Schriger-DL Stitzer-ML Stachenko-S Tommasello-A Villejo-L Wewers-ME Baker-TB, "The Agency for Health-Care Policy and Research Smoking Cessation Clinical-Practice Guideline", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 1996, Vol 275, Iss 16, pp 1270-1280

Fisch-R Daniel-HD Gunther-H, "Motives to Study Psychology - A

Cross-National Comparison Between Brazil and Germany", INTERNATIONAL JOURNAL OF PSYCHOLOGY,1992, Vol 27, Iss 3-4, pp 560-560

Fischbach-M Sabbioni-E Bromley-P, "Induction of the Human Growth-Hormone Gene Placed Under Human Hsp70 Promoter Control in Mouse Cells - A Quantitative Indicator of Metal Toxicity", CELL BIOLOGY AND TOXICOLOGY,1993, Vol 9, Iss 2, pp 177-188

Fischer-MM Frohlich-J Gassler-H, "An Exploration into the Determinants of Patent Activities - Some Empirical-Evidence for Austria", REGIONAL STUDIES,1994, Vol 28, Iss 1, pp 1-12

Fischhoff-B, "Hindsight - Thinking Backwards - A Citation-Classic Commentary on Hindsight Not-Equal Foresight - The Effect of Outcome Knowledge on Judgment Under Uncertainty by Fischhoff,B.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 26, pp 8-8

Fisher-M Friedman-SB Strauss-B, "The Effects of Blinding on Acceptance of Research Papers by Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 143-146

Fisher-TD, "A Comparison of Various Measures of Family Sexual Communication - Psychometric Properties, Validity, and Behavioral-Correlates", JOURNAL OF SEX RESEARCH,1993, Vol 30, Iss 3, pp 229-238

Fishman-DL Stone-VL Dipaula-BA, "Where Should the Pharmacy Researcher Look First - Comparing International-Pharmaceutical-Abstracts and Medline", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION 1996, Vol 84, Iss 3, pp 402-408

Fiske-DW Campbell-DT, "Citations Do Not Solve Problems", PSYCHOLOGICAL BULLETIN,1992, Vol 112, Iss 3, pp 393-395

Flannery-RB, "Violence in the Workplace, 1970-1995 - A Review of the Literature", AGGRESSION AND VIOLENT BEHAVIOR 1996, Vol 1, Iss 1, pp 57-68

Flapper-SDP Fortuin-L Stoop-PPM, "Towards Consistent Performance Management-Systems", INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT 1996, Vol 16, Iss 7, pp 27+

Fletcher-JC Hoffmann-DE, "Ethics Committees - Time to Experiment with Standards", ANNALS OF INTERNAL MEDICINE,1994, Vol 120, Iss 4, pp 335-338

Fletcher-RH Fletcher-SW, "Whos Responsible", ANNALS OF INTERNAL MEDICINE,1993, Vol 118, Iss 8, pp 645-646

Flotte-TJ, "Research by Pathologists in the United-States - Analysis of Publications", MODERN PATHOLOGY,1993, Vol 6, Iss 4, pp 484-486

Flowers-TJ, "Sun, Salt, and Halophytes - A Citation-Classic Commentary on the Mechanism of Salt Tolerance in Halophytes by Flowers,T.J., Troke,P.F., Yeo,A.R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 46, pp 8-8

Flynn-TG, "Atrial Natiruretic Peptide - A Citation-Classic Commentary on the Amino-Acid-Sequence of an Atrial Peptide with Potent Diuretic and Natriuretic Propertiesby Flynn,T.G., Debold,M.L., and Bold,A.J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 24, pp 8-8

Fogarty-TJ, "The Imagery and Reality of Peer-Review in the Us - Insights from Institutional Theory", ACCOUNTING ORGANIZATIONS AND SOCIETY 1996, Vol 21, Iss 2-3, pp 243-267

Fogarty-TJ Saftner-DV, "Academic Department Prestige - A New Measure Based on the Doctoral Student Labor-Market", RESEARCH IN HIGHER EDUCATION,1993, Vol 34, Iss 4, pp 427-449

Fondiller-SH, "Editorial Peer-Review - Is Nursing at Risk", NURSING & HEALTH CARE,1994, Vol 15, Iss 3, pp 142-148

Foon-KA, "Hematologic Malignancies - Correlating Morphology with Immunology - A Citation-Classic Commentary on Immunological Classification of Leukemia and Lymphoma by Foon,K.A., Todd,R.F.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 42, pp 8-8

Forer-A Behnke-O, "Microtubules Are Not All the Same - A Citation-Classic Commentary on Evidence for 4 Classes of Microtubules in Individual Cells by Behnke,O., and Forer,A.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 6, pp 8-8

Formann-AK, "Academic Personnel-Selection - Description and Prognosis of the Decisions Made by the Committee for the Selection of Candidates for a Full Professorship", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 401-414

Foroughi-A Perkins-WC Jelassi-MT, "An Empirical-Study of an Interactive, Session-Oriented Computerized Negotiation Support System (Nss)", GROUP DECISION AND NEGOTIATION 1995, Vol 4, Iss 6, pp 485-512

Forsdyke-DR, "Bicameral Grant Review - An Alternative to Conventional Peer-Review", FASEB JOURNAL,1991, Vol 5, Iss 9, pp 2313-2314

Forsdyke-DR, "On Giraffes and Peer-Review", FASEB JOURNAL,1993, Vol 7, Iss 8, pp 619-621

Fortune-AE, "More Is Not Better - Manuscript Reviewer Competence and Citations - From the Past Editor-in-Chief of the Journal of Social-Work Education", RESEARCH ON SOCIAL WORK PRACTICE,1992, Vol 2, Iss 4, pp 505-510

Foster-L, "Aall Task-Force on Citation Formats Report March 1, 1995", LAW LIBRARY JOURNAL 1995, Vol 87, Iss 3, pp 580+

Fox-E Tulsky-JA, "Evaluation Research and the Future of Ethics Consultation", JOURNAL OF CLINICAL ETHICS 1996, Vol 7, Iss 2, pp 146-149

Fox-L, "Support for Continuing the New-York-State-Journal-of-Medicine as a Peer-Reviewed Scientific Publication", NEW YORK STATE JOURNAL OF MEDICINE,1993, Vol 93, Iss 3, pp 200-200

Fox-MF, "Research, Teaching, and Publication Productivity - Mutuality Versus Competition in Academia", SOCIOLOGY OF EDUCATION,1992, Vol 65, Iss 4, pp 293-305

Fox-MF, "Scientific Misconduct and Editorial and Peer-Review Processes", JOURNAL OF HIGHER EDUCATION,1994, Vol 65, Iss 3, pp 298-309

Foy-CD, "Metal Toxicity Review Stimulates Plant Breeders - A Citation-Classic Commentary on the Physiology of Metal Toxicity in Plants by Foy,C.D., Chaney,R.L., White,M.C.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 24, pp 8-8

France-G, "Centralized Versus Decentralized Funding of Evaluative Research - Impact on Medical Technology Policy in Italy", SOCIAL SCIENCE & MEDICINE,1994, Vol 38, Iss 12, pp 1635-1641

Frank-E, "Editors Requests of Peer Reviewers - A Study and a Proposal", PREVENTIVE MEDICINE 1996, Vol 25, Iss 2, pp 102-104

Frank-G, "The Use of the Rorschach with Hispanic Americans", PSYCHOLOGICAL REPORTS,1993, Vol 72, Iss 1, pp 276-278

Frankish-CJ Linden-W, "Spouse-Pair Risk-Factors and Cardiovascular Reactivity", JOURNAL OF PSYCHOSOMATIC RESEARCH 1996, Vol 40, Iss 1, pp 37-51

Fraser-MW, "Scholarship and Research in Social-Work - Emerging Challenges", JOURNAL OF SOCIAL WORK EDUCATION,1994, Vol 30, Iss 2, pp 252-266

Fraser-RC Mckinley-RK Mulholland-H, "Consultation Competence in General-Practice - Testing the Reliability of the Leicester Assessment Package", BRITISH JOURNAL OF GENERAL PRACTICE,1994, Vol 44, Iss 384, pp 293-296

Freebairn-J, "Evaluating the Level and Distribution of Benefits from Dairy-Industry Research", AUSTRALIAN JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 36, Iss 2, pp 141-165

Frei-JV, "Peer-Review Anonymity", CANADIAN MEDICAL ASSOCIATION JOURNAL,1993, Vol 149, Iss 7, pp 928-928

Frenk-S, "Aminonucleoside-Induced Nephropathy - A Citation-Classic Commentary on Experimental Nephrotic Syndrome Induced in Rats by Aminonucleoside - Renal Lesions and Body Electrolyte-Composition - By Frenk,S., Antonowicz,I., Craig,J.M., and Metcoff,J.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 51-52, pp 9-9

Frenkel-A Reiss-T Maital-S Koschatzky-K Grupp-H, "Technometric Evaluation and Technology Policy - The Case of Biodiagnostic Kits in Israel", RESEARCH POLICY,1994, Vol 23, Iss 3, pp 281-292

Fretwell-S, "Say That in Algebra - A Citation-Classic Commentary on Territorial Behavior and Other Factors Influencing Habitat Distribution in Birds .1. Theoretical Development by Fretwell,S.D., and Lucas,H.L.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 8, pp 8-8

Frick-MH, "Cholesterol and Coronaries - A Citation-Classic Commentary on Helsinki Heart-Study - Primary-Prevention Trial with Gemfibrozil in Middle-Aged Men with Dyslipidemia - Safety of Treatment, Changes in Risk-Factors, and Incidence of Coronary Heart-Disease by Frick,M.H., Elo,O., Haapa,K., Heinonen,O.P., Heinsalmi,P., Helo,P., Huttunen,J.K., Kaitaniemi,P., Koskinen,P., Manninen,V., Maenpaa,H., Malkonen,M., Manttari,M., Norola,S., Pasternack,A., Pikkarainen,J., Romo,M., Sjoblom,T., Nikkila,E.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 38, pp 8-8

Frieden-C, "Defining Hysteretic Enzymes - A Citation-Classic Commentary on Aspects of Regulation of Metabolic Processes - The Hysteretic Enzyme Concept by Frieden,C.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 44, pp 11-11

Friedman-DP, "Manuscript Peer-Review at the Ajr - Facts, Figures, and Quality Assessment", AMERICAN JOURNAL OF ROENTGENOLOGY,1995, Vol 164, Iss 4, pp 1007-1009

Friedman-SG, "The Intent of Peer-Reviewed Journals", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 633-633

Friman-PC Allen-KD Kerwin-MLE Larzelere-R, "Changes in Modern

Psychology - A Citation Analysis of the Kuhnian Displacement Thesis", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 6, pp 658-664

Froehle-TC Rominger-RL, "Directions in Consultation Research - Bridging the Gap Between Science and Practice", JOURNAL OF COUNSELING AND DEVELOPMENT,1993, Vol 71, Iss 6, pp 693-699

Froese-AD Boswell-KL Garcia-ED Koehn-LJ Nelson-JM, "Citing Secondary Sources - Can We Correct What Students Do Not Know", TEACHING OF PSYCHOLOGY 1995, Vol 22, Iss 4, pp 235-238

Frumau-CCF, "Choices in Research-and-Development and Business Portfolio in the Electronics Industry - What the Bibliometric Data Show", RESEARCH POLICY,1992, Vol 21, Iss 2, pp 97-124

Fuhrman-J, "Bacterial-Growth in the Sea - A Citation-Classic Commentary on Bacterioplankton Secondary Production Estimates for Coastal Waters of British-Columbia, Antarctica, and California by Fuhrman,J.A., and Azam,F.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 8, pp 8-8

Fuhrman-JA, "Measuring Marine Bacterial-Growth - A Citation-Classic Commentary on Thymidine Incorporation as a Measure of Heterotrophic Bacterioplankton Production in Marine Surface Waters - Evaluation and Field Results by Fuhrman,J.A. and Azam,F.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 38, pp 8-8

Fuller-S, "Peer-Review Is Not Enough - Editors Must Work with Librarians to Ensure Access to Research", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 147-147

Fuller-SzzTitle: Peer-Review Is Not Enough - Editors Must Work with Librarians to Ensure Access to Research", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 147-147

Fullerton-JT, ",1994 Task-Analysis of American Certified Nurse-Midwifery", JOURNAL OF NURSE-MIDWIFERY,1994, Vol 39, Iss 6, pp 348-357

Fullerton-JT, "Evaluation of Research Studies .4. Validity and Reliability - Concepts and Application", JOURNAL OF NURSE-MIDWIFERY,1993, Vol 38, Iss 2, pp 121-125

Fulton-JH, "ISI Medical Documentation Service - Support for Biomedical and Pharmaceutical Research", CURRENT CONTENTS,1992, Vol 25, Iss JUN, pp 5-9

Fulton-JH, "Morse,Elliott,How 1916-,1992 - Obituary", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol 81, Iss 4, pp 464-469

Funakoshi-A Kono-A Miyasaka-K, "Lack of Appropriate Citation", AMERICAN JOURNAL OF PHYSIOLOGY-ENDOCRINOLOGY AND METABOLISM 1996, Vol 33, Iss 2, pp E373-E373

Funder-K Edgar-D Whithear-D Brownlee-H Glezer-H Harrison-M Hartley-R Mcdonald-P Ochiltree-G Wolcott-I, "Family Studies in Australia", MARRIAGE AND FAMILY REVIEW 1996, Vol 22, Iss 3-4, pp 287-332

Funkhouser-ET, "The Evaluative Use of Citation Analysis for Communication Journals", HUMAN COMMUNICATION RESEARCH 1996, Vol 22, Iss 4, pp 563-574

Furness-P, "Promoting Research into Peer-Review - Referees Should Provide References", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6953, pp 539-539

Furnham-A Bonnett-C, "British Research Productivity in Psychology 1980-1989 - Does the Lotka-Price Law Apply to University Departments as It Does to Individuals", PERSONALITY AND INDIVIDUAL DIFFERENCES,1992, Vol 13, Iss 12, pp 1333-1341

Furr-LA, "The Relative Influence of Social-Work Journals - Impact Factors vs Core Influence", JOURNAL OF SOCIAL WORK EDUCATION,1995, Vol 31, Iss 1, pp 38-45

Fusaro-JA Royce-CA, "A Reanalysis of Research Data", PERCEPTUAL AND MOTOR SKILLS 1995, Vol 81, Iss 3, pp 858-858

Gabel-RA, "Quality Assurance Peer-Review for Recredentialing Relicensure in New-York-State", INTERNATIONAL ANESTHESIOLOGY CLINICS,1992, Vol 30, Iss 2, pp 93-101

Gabolde-I, "First International Conference on the Evaluation of Research Technology and Development - 26, 27 and 28 April 1995, Thessaloniki, Greece - Opening Address", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 317-320

Gabriel-CJ, "Life-Sciences Peer-Review at NASA", SCIENCE,1994, Vol 265, Iss 5169, pp 170-170

Gaillard-J, "Use of Publication Lists to Study Scientific Production and Strategies of Scientists in Developing-Countries", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 57-73

Galante-E Sala-C, "Research-and-Development Evaluation at the Italian-
National-Research-Council - The Agricultural Sector", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 207-222

Gale-P, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 183-184

Galle-WP Koen-CM, "Tenure and Promotion After Penn V Eeoc .1. Open Files Mean Less Candid Peer Reviews", ACADEME-BULLETIN OF THE AAUP,1993, Vol 79, Iss 5, pp 19-23

Game-FL Neary-RH, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 421-421

Gans-SL, "Recognition in Peer-Review", JOURNAL OF PEDIATRIC SURGERY,1993, Vol 28, Iss 2, pp 121-122

Gardner-W Wilcox-BL, "Political Intervention in Scientific Peer-Review - Research on Adolescent Sexual-Behavior", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 9, pp 972-983

Garfield-E, "A Citationist Perspective on Science in Taiwan - Most Cited Papers, Institutions, and Authors, 1981-,1992", CURRENT CONTENTS,1993, Vol 17, Iss APR, pp 3-12

Garfield-E, "A Citation Analysis of Austrian Medical-Research and Wiener-Klinische-Wochenschrift", WIENER KLINISCHE WOCHENSCHRIFT,1991, Vol 103, Iss 11, pp 318-325

Garfield-E, "A Citationist Perspective on Xenobiotics Research, 1981-,1992 - The Highest Impact Papers, Institutions, and Authors", CURRENT CONTENTS,1993, Vol 3, Iss JAN, pp 3-14

Garfield-E, "A Tribute to the New-York-Academy-of-Sciences - Cullinan,Denis on the Academy History, Future, and Classic Papers - An Introduction to the New-York-Academy-of-Sciences-Annals - From the Founding Through the Future by Cullinan,Denis,M.", CURRENT CONTENTS,1993, Vol 49, Iss DEC, pp 3-12

Garfield-E, "Activism by Scientists at the Grass-Roots Level Is Needed to Solve the Research Funding Crisis", SCIENTIST,1991, Vol 5, Iss 9, pp 14-14

Garfield-E, "An International Perspective on Drug Bulletins and Their Place in the Review Literature - Introduction to Drug Bulletins Are Part of the Scientific Literature by Herxheimer,A.", CURRENT CONTENTS,1991, Vol 7, Iss FEB, pp 3-10

Garfield-E, "Announcing Current-Contents-on-Diskette-with-Abstracts", CURRENT CONTENTS,1991, Vol 19, Iss MAY, pp 5-9

Garfield-E, "Citation-Classics in Clinical-Chemistry Highlight the Cumulative Impact of Useful Methods - A Tribute to Editor King,John,Stanton - An Introduction to Remonstrance, Apostrophe, and Valedictory - By King,J.S. (Reprinted from Clinical-Chemistry, Vol 36, Pg 413-414, 1990)", CURRENT CONTENTS,1991, Vol 37, Iss SEP, pp 3-8

Garfield-E, "Citation-Classics(R) - From Obliteration to Immortality -And the Role of Autobiography in Reporting the Realities Behind High-Impact Research", CURRENT CONTENTS,1993, Vol 45, Iss NOV, pp 5-10

Garfield-E, "Citation Searches Can Be Powerful Tools in Combating Redundant Publication", SCIENTIST,1993, Vol 7, Iss 8, pp 12-12

Garfield-E, "Cocitation Analysis of the Scientific Literature - Small,Henry on Mapping the Collective Mind of Science - An Introduction to Macrolevel Changes in the Structure of Cocitation Clusters - 1983-1989 by Small,Henry (Reprinted from Scientometrics, Vol 26, Pg 5-20, ,1993)", CURRENT CONTENTS,1993, Vol 19, Iss MAY, pp 3-13

Garfield-E, "Contract Research Services at ISI - Citation Analysis for Government, Industry, and Academic Clients", CURRENT CONTENTS,1992, Vol 23, Iss JUN, pp 5-7

Garfield-E, "Despite Problems with Peer-Review, Science Publishing Is Healthier Than Ever", SCIENTIST,1993, Vol 7, Iss 18, pp 12-12

Garfield-E, "Djerassi,Carl Receives ,1992 Priestley Award - Prolific Scientist Publishes Autobiography Depicting Journey into Metaphysical Realm", CURRENT CONTENTS,1992, Vol 19, Iss MAY, pp 5-10

Garfield-E, "From Individual to Institutional Integrity and Back - A Perspective by Dowdle,Walter of the Centers-for-Disease-Control - Introduction to Science, Politics, and CDC by Dowdle,Walter", CURRENT CONTENTS,1991, Vol 41, Iss OCT, pp 5-11

Garfield-E, "From Current-Comments(R) to Citation-Comments - Continuing a 31-Year Series of Current-Contents(R) Essays with a New Focus", CURRENT CONTENTS,1993, Vol 51-2, Iss DEC, pp 3-5

Garfield-E, "How Science Works - Hull,David,L. Reviews the Scientific Attitude by Grinnell,F.", CURRENT CONTENTS,1992, Vol 39, Iss SEP, pp 3-4

Garfield-E, "How Can Impact Factors Be Improved", BRITISH MEDICAL JOURNAL 1996, Vol 313, Iss 7054, pp 411-413

Garfield-E, "Huichol Art and Culture - Vanishing Treasures of the Sierra-Madre - Introduction to Dancing Through the Gods Eye by

Vonbolschwing,Maria (Reprinted from Hola-Amigas, Vol 2, Pg 11-13, ,1992)", CURRENT CONTENTS,1993, Vol 13, Iss MAR, pp 3-12

Garfield-E, "In Truth, the Flood of Scientific Literature Is Only a Myth", SCIENTIST,1991, Vol 5, Iss 17, pp 11

Garfield-E, "In Appreciation of Nalimov,Vasily,Vasilyevich - Thompson,Angela Profile of a Remarkable Scholar and Courageous Individual - Introduction to Nalimov,Vasily,Vasilyevich - Russian Visionary by Thompson,Angela,M.", CURRENT CONTENTS,1993, Vol 31, Iss AUG, pp 3-9

Garfield-E, "Inventors and Inventiveness - A Mix of Curiosity, Creativity, Paranoia, Persistence, and Illusions of Wealth - Introduction to Inventors and Inventiveness - A Mix of Curiosity, Creativity, Paranoia, Persistence, and Illusions of Wealth by King,Christopher", CURRENT CONTENTS,1991, Vol 5, Iss FEB, pp 5-6

Garfield-E, "Is Homosexuality Biologically Determined - Introduction to Sex and the Single Brain - (An Interview with Mcewen,Bruce on Differences in Our Most Complicated Organ) by Blum,Susan (Reprinted from Search, Vol 2, ,1992)", CURRENT CONTENTS,1992, Vol 21, Iss MAY, pp 3-8

Garfield-E, "ISI Medical Documentation Service (MDs) - Monitoring the Literature for the Pharmaceutical and Biomedical Industries", CURRENT CONTENTS,1992, Vol 25, Iss JUN, pp 3-5

Garfield-E, "Kranzberg,Mel Receives Bernal Prize as Pioneering Historian of Technology - An Introduction to Acceptance Speech of Kranzberg,Melvin - Jd-Bernal-Prize (,1991) - Society-for-Social-Studies-of-Science, Cambridge, Ma, Nov 14-17, ,1991 by Kranzberg,Melvin", CURRENT CONTENTS,1992, Vol 13, Iss MAR, pp 3-9

Garfield-E, "Kronick,David Guide Exposes the Bones of 17th-Century and 18th-Century Scientific and Technical Journals", CURRENT CONTENTS,1992, Vol 27, Iss JUL, pp 3-5

Garfield-E, "Lawlor,Bonnie Silver Anniversary at ISI(R) - A Tribute", CURRENT CONTENTS,1993, Vol 15, Iss APR, pp 3-5

Garfield-E, "Mechanical Indexing, Structural Linguistics and Information-Retrieval", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 2, pp 164-165

Garfield-E, "Multilingual Communication Essential for Science (Reprinted from the Scientist, September, 1994)", INTERDISCIPLINARY SCIENCE REVIEWS 1995, Vol 20, Iss 3, pp 179-180

Garfield-E, "NAS and Institute-of-Medicine, Alarmed by Animal Rights Activists, Highlight Medical Advances Based on Animal Research - Introduction to Science, Medicine and Animals", CURRENT CONTENTS,1991, Vol 39, Iss SEP, pp 3-12

Garfield-E, "New Sci(TM) and Ssci(TM) Cd ROM Editions Include Abstracts, Key Words Plus(TM), and Monthly Updates - An Introduction to Science-Citation-Index/Science-Citation-Index with Abstracts on Cd-ROM by Tomaivolo,Nicholas,G., Trolley,Jacqueline (Reprinted from Cd-ROM Librarian, Vol 7, Pg 34, ,1992)", CURRENT CONTENTS,1993, Vol 7, Iss FEB, pp 3-12

Garfield-E, "New Scientist Examines AIDS Research with ISI(R)S Citation Data - Introduction to Has the AIDS Research Epidemic Spread Too Far by Brown,Phyllida (Reprinted from New Scientist, Vol 138, Pg

12-15, ,1993)", CURRENT CONTENTS,1993, Vol 27, Iss JUL, pp 3-10
Garfield-E, "New Chemistry Citation Index on Cd-ROM Comes with Abstracts, RelatedRecords, and Key-Words-Plus", CURRENT CONTENTS,1992, Vol 3, Iss JAN, pp 5-9
Garfield-E, "Of Nobel Class .1. An Overview of ISI Studies on Highly Cited Authors and Nobel Laureates - Introduction to of Nobel Class - A Citation Perspective on High-Impact Research Authors by Garfield,Eugene and Welljamsdorof,Alfred (Reprinted from Theoretical Medicine, Vol 13, ,1992)", CURRENT CONTENTS,1992, Vol 33, Iss AUG, pp 3-13
Garfield-E, "Of Nobel Class .2. Forecasting Nobel-Prizes Using Citation Data and the Odds Against It - Introduction to of Nobel Class - A Citation Perspective on High-Impact Research Authors .2. By Garfield,Eugene, andWelljamsdorof,Alfred (Reprinted from Theoretical Medicine, Vol 13, Pg 117, ,1992)", CURRENT CONTENTS,1992, Vol 35, Iss AUG, pp 3-12
Garfield-E, "Parascience, Pseudoscience, and Political-Power Holton,Gerald on the Antiscience Phenomenon - And Why It Should Not Be Dismissed as a Harmless Fringe", CURRENT CONTENTS,1992, Vol 45, Iss NOV, pp 3-5
Garfield-E, "Psychiatrist and Biographer Differ over Sexton,Anne Suicide - Was It Preventable or Inevitable - An Introduction to Foreword to Sexton,Anne - A Biography by Middlebrook,D.W. by Orne,Martin,T.", CURRENT CONTENTS,1992, Vol 11, Iss MAR, pp 5-13
Garfield-E, "Psychology Research, 1986-1990 - A Citationist Perspective on the Highest Impact Papers, Institutions, and Authors", CURRENT CONTENTS,1992, Vol 41, Iss OCT, pp 5-13
Garfield-E, "Reaffirming the Central Role of the Scientific Literature - Lederberg,Joshua Discusses the Print and Electronic Media", CURRENT CONTENTS,1993, Vol 1, Iss JAN, pp 3-4
Garfield-E, "Reflections on the Gene (Muller,H.J. 1947) and theImpact of This Article on Modern Genetics - Introduction to the Gene (Muller,H.J. 1947) by Lederberg,Joshua (Reprinted from Genetics, Vol 129, Pg 313-316, ,1991)", CURRENT CONTENTS,1992, Vol 7, Iss FEB, pp 3-5
Garfield-E, "Reinterpreting the Legacy of Barnes,Albert,C. .1. Glanton,Richard Shapes a New Image for Philadelphia Best-Kept Secret - Introduction to Opening the Barnes Door - How America Most Paranoid Art-Museum Got That Way, and How, Under New Management, Dramatic Changes Are on the Way .1. (Reprinted from Philadelphia Inquirer Magazine)", CURRENT CONTENTS,1991, Vol 13, Iss APR, pp 3-11
Garfield-E, "Reinterpreting the Legacy of Barnes,Albert,C. .2. Personal, Legal, and Financial Trials - Introduction to Opening the Barnes Door - How America Most Paranoid Art-Museum Got That Way, and How, Under New Management, Dramatic Changes Are on the Way .2. By Fleeson,Lucinda (Reprinted from Philadelphia Inquirer Magazine, November 11, 1990, Pg 22-35)", CURRENT CONTENTS,1991, Vol 15, Iss APR, pp 5-
Garfield-E, "Science Times - Influential in Popularizing Science for the Layman", CURRENT CONTENTS,1991, Vol 35, Iss SEP, pp 5-11
Garfield-E, "Science-Watch Takes the Pulse of British Medicine and Other Fields - An Introduction to Critical Condition - Clinical

Research in UK Fading Fast (Reprinted from Science Watch, Vol 3, Pg 1-2, August ,1992)", CURRENT CONTENTS,1992, Vol 51-2, Iss DEC, pp 3-9

Garfield-E, "Scientists Should Understand the Limitations as Well as the Virtues of Citation Analysis", SCIENTIST,1993, Vol 7, Iss 14, pp 12-12

Garfield-E, "Shedding New Light on the Photosynthetic Process - Glazer,Alexander,N. Receives the ,1991 NAS Award for Excellence in Scientific Reviewing", CURRENT CONTENTS,1991, Vol 17, Iss APR, pp 3-8

Garfield-E, "Social-Science Quotations by Sills,David,L. and Merton,Robert,K. - Revisiting the New Paperback Edition", CURRENT CONTENTS,1992, Vol 43, Iss OCT, pp 3-4

Garfield-E, "Social-Science Quotations - A New Volume of a Famous Encyclopedia Edited by Sills,David,L. and Merton,Robert,K. - Introduction to a Quotation from the International Encyclopedia of the Social-Sciences, Volume 19, Social-Science Quotations by Sills,David,L., and Merton,Robert,K. (Reprinted from International Encyclopedia of the Social-Science, - Quotations, Vol 19, ,1991)", CURRENT CONTENTS,1991, Vol 23, Iss JUN, pp 5-8

Garfield-E, "Spence,Janet,Taylor Receives the ,1993 NAS Award for Scientific Reviewing", CURRENT CONTENTS,1993, Vol 41, Iss OCT, pp 3-8

Garfield-E, "The 1990 Nobel-Prize Winners - A Citationist Retrospective", CURRENT CONTENTS,1991, Vol 11, Iss MAR, pp 3-9

Garfield-E, "The 1990 Nobel-Prize Winners - A Citationist Retrospective", CURRENT CONTENTS,1991, Vol 11, Iss MAR, pp 3-9

Garfield-E, "The Impact of Citation Indexes on Biochemists and Sociologists - A Survey by Hargens,L. and Schuman,H. .1. Methodology - Introduction to Citation Counts and Social Comparisons - Scientists Use and Evaluation of Citation Index Data by Hargens,Lowell,L., and Schuman,Howard (Reprinted from Social-Science Research, Vol 19, Pgs 205-221, 1990)", CURRENT CONTENTS,1991, Vol 1, Iss JAN, pp 5-12

Garfield-E, "The Birth of Fullerene Chemistry - Kroto,Harold,W. Discusses New Lines of Buckyball Research in a Science-Watch(R) Interview - Introduction to the Search for Carbon in-Space and the Fullerene Fallout by Kroto,H.W.", CURRENT CONTENTS,1993, Vol 37, Iss SEP, pp 3-7

Garfield-E, "The Role of Undergraduate Colleges in Research .2. Highest Impact Institutions and Most-Cited Papers, 1981-,1992", CURRENT CONTENTS,1993, Vol 25, Iss JUN, pp 3-9

Garfield-E, "The Dependent Care Dilemma - Corporate Practices, Legislative Solutions - Introduction to Dependent Care in the 1990s - Business and Government Share the Working Familys Burden .2. Seeking a Solution", CURRENT CONTENTS,1991, Vol 31, Iss AUG, pp 5-5

Garfield-E, "The ,1991 Nobel-Prize Winners - From Patch Clamps (Sakmann and Neher) to Spaghetti Theory (Degennes),Social Costs (Coase), and NMR (Ernst) - Were All Citation Superstars", CURRENT CONTENTS,1992, Vol 5, Iss FEB, pp 3-9

Garfield-E, "The Most-Cited Papers of All Time, Sci 1945-1988 .4. The Papers Ranked 301-400", CURRENT CONTENTS,1991, Vol 21, Iss MAY, pp 5-16

Garfield-E, "The Double Helix 40 Years Later - Lederberg,Joshua Personal Commentary About Its Impact on Basic Research - An

Introduction to What the Double Helix (1953) Has Meant for Basic Biomedical Science by Lederberg,Joshua (Reprinted from Jama, Vol 269, Pgs 1981-1985, ,1993)", CURRENT CONTENTS,1993, Vol 39, Iss SEP, pp 3-12

Garfield-E, "The New Materials Science-Citation-Index on Cd-ROM, with Abstracts, RelatedRecords, and Key-Words-Plus", CURRENT CONTENTS,1992, Vol 31, Iss AUG, pp 3-11

Garfield-E, "The-Scientist(R) Newspaper - 7 Years on the Human and Professional Sides of Science", CURRENT CONTENTS,1993, Vol 43, Iss OCT, pp 3-6

Garfield-E, "The Relationship Between Mechanical Indexing, Structural Linguistics and Information-Retrieval", JOURNAL OF INFORMATION SCIENCE,1992, Vol 18, Iss 5, pp 343-354

Garfield-E, "The Languages of Science Revisited - A Focus on Microbiology, 1981-,1991 - An Introduction to the Microbiology Literature - Languages of Publication and Their Relative Citation Impact by Garfield,Eugene, and Welljamsdorof,Alfred (Reprinted from Fems Microbiology Letters, Vol 100, Pg 33-37, ,1992)", CURRENT CONTENTS,1992, Vol 47, Iss NOV, pp 3-10

Garfield-E, "The Dependent Care Dilemma - A Growing Problem - An Introduction to Dependent Care in the 1990s - Business and Government Share the Working Familys Burden .1. Defining the Need, by Miller,Cynthia", CURRENT CONTENTS,1991, Vol 29, Iss JUL, pp 5-10

Garfield-E, "The New Biomedical-Engineering Citation Index Database on Cd-ROM, Containing Searchable Abstracts, Related Records, and Key-Words-Plus", CURRENT CONTENTS,1992, Vol 29, Iss JUL, pp 3-10

Garfield-E, "The Role of Undergraduate Colleges in Research .1. Highest Output, Most-Cited, and Highest Impact Institutions, 1981-,1992", CURRENT CONTENTS,1993, Vol 23, Iss JUN, pp 5-11

Garfield-E, "The ,1993 Scott,John Awards Go to Croce,Carlo and Smalley,Richard", CURRENT CONTENTS,1993, Vol 47, Iss NOV, pp 3-7

Garfield-E, "The Symbiosis of Clinical-Practice and Basic Research - Lederberg,Joshua on the Interface of Science and Medicine - An Introduction to the Interface of Science and Medicine by Lederberg,Joshua (Reprinted from theMount-Sinai Journal of Medicine, Vol 59, Pg 380-383, ,1992)", CURRENT CONTENTS,1993, Vol 21, Iss MAY, pp 3-8

Garfield-E, "The Science-Religion Connection an Introduction to Science and Religion - From Warfare over Sociobiology to a Working Alliance by Sharpe,Kevin,J.", CURRENT CONTENTS,1991, Vol 25, Iss JUN, pp 5-13

Garfield-E, "The New Materials Science-Citation-Index on Cd-ROM, with Abstracts, RelatedRecords, and Key-Words-Plus", CURRENT CONTENTS,1992, Vol 31, Iss AUG, pp 3-11

Garfield-E, "The New Biotechnology and Neuroscience Citation Indexes on Cd-ROM Include Abstracts and Increased Coverage", CURRENT CONTENTS,1992, Vol 1, Iss JAN, pp 3-8

Garfield-E, "The Uses and Limitations of Citation Data as Science Indicators - An Overview for Students and Nonspecialists - Introduction to Citation Data - Their Use as Quantitative Indicators for Science and Technology Evaluation and Policy Making by Garfield,Eugene and Welljams-Dorof,Alfred (Reprinted from Science and

Public-Policy, Vol 19, Pg 321-327, ,1992)", CURRENT CONTENTS,1992, Vol 49, Iss DEC, pp 3-13

Garfield-E, "The Restoration of Sorm,Frantisek - Prolific Czech Scientist Obeyed His Conscience and Became a Nonperson", CURRENT CONTENTS,1992, Vol 15, Iss APR, pp 3-8

Garfield-E, "The Impact of Citation Indexes on Biochemists and Sociologists - A Survey by Hargens,L. and Schuman,H. .2. Results and Conclusions - Who Uses What, When, and Why - Introduction to Citation Counts and Social Comparisons - Scientists Use and Evaluation of Citation Index Data (Reprinted from Social-Science Research, Vol 19, Pg 205-221, 1990)", CURRENT CONTENTS,1991, Vol 3, Iss JAN, pp 5-11

Garfield-E, "The 1986 Most-Cited Chemistry Articles - Enzymes in Organic-Synthesis and Odd-Cluster Soot Up, While Superconductivity Disappears (for Now) - Introduction to the 1986 Chemistry Articles Most Cited 1986-1988, Plus 1989-1990 Data - Catalysts, Clusters, Kinetics, and Theory - By Szafran,Zvi", CURRENT CONTENTS,1991, Vol 27, Iss JUL, pp 3-15

Garfield-E, "Theoretical Medicines Special Issue on the Nobel-Prizes and Their Effect on Science - Introduction to Discovery, Theory Change, and the Nobel-Prize - On the Mechanisms of Scientific Evolution - An Introduction by Lindahl,B.I.B. (Reprinted from Theoretical Medicine, Vol 13, Pg 97-231, ,1992)", CURRENT CONTENTS,1992, Vol 37, Iss SEP, pp 3-12

Garfield-E, "Theoretical Medicines Special Issue on the Nobel-Prizes and Their Effect on Science - Introduction to Discovery, Theory Change, and the Nobel-Prize - On the Mechanisms of Scientific Evolution - An Introduction by Lindahl,B.I.B. (Reprinted from Theoretical Medicine, Vol 13, Pg 97-231, ,1992)", CURRENT CONTENTS,1992, Vol 37, Iss SEP, pp 3-12

Garfield-E, "Tinnitus - Some Sound Advice", CURRENT CONTENTS,1991, Vol 33, Iss AUG, pp 5-7

Garfield-E, "To What Extent Is the Research Literature Cited Hargens,Lowell and Bott,David Examine Citation Rates in Sociology - An Introduct to Are Sociologists Publications Uncited - Citation Rates of Journal Articles, Chapters and Books by Bott,David,M., and Hargens,Lowell,L. (Reprinted from the American Sociologist, Summer, Pg 147-158, ,1991)", CURRENT CONTENTS,1993, Vol 5, Iss FEB, pp 3-12

Garfield-E, "Using the Citation Classic(R) Database for Science Studies .2. Astin,Helen on How Men and Women Perceive Their High-Impact Works - Introduction to Citation-Classics - Womens and Mens Perceptions of Their Contributions to Science by Astin,Helen,S. (Reprinted from the Outer Circle - Women in the Scientific Community, ,1991)", CURRENT CONTENTS,1993, Vol 35, Iss AUG, pp 5-6

Garfield-E, "Using the Citation Classic(R) Database for Science Studies .1. Astin,Helen on Gender Differences in Author Productivity - Introduction to Citation-Classics - Womens and Mens Perceptions of Their Contributions to Science by Astin,Helen,S. (Reprinted from the Outer Circle - Women in the Scientific Community, Pg 57-70, ,1991)", CURRENT CONTENTS,1993, Vol 33, Iss AUG, pp 3-10

Garfield-E, "Vonneumann,John, Mauchly,John, and the Invention of the Modern Computer - A Story of Genius and Controversy - An Introduction to Heppenheimer,T.A. Reflection on How Vonneumann Showed

the Way", CURRENT CONTENTS,1991, Vol 9, Iss MAR, pp 5-5

Garfield-E, "Watson,Robert,T. of NASA Receives NAS Award for Scientific Reviewing of Stratospheric Ozone Dynamics", CURRENT CONTENTS,1992, Vol 17, Iss APR, pp 5-10

Garfield-E, "What Citations Tell Us About Canadian Research", CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE-REVUE CANADIENNE DES SCIENCES DE L INFORMATION ET DE BIBLIOTHECONOMIE,1993, Vol 18, Iss 4, pp 14-35

Garfield-E, "When to Cite", LIBRARY QUARTERLY 1996, Vol 66, Iss 4, pp 449-458

Garfield-E, "Will Hot Papers Ever Become Hot Properties - A Provocative Viewpoint by Science-Watch(R) EditorPendlebury,David - Introduction to Are New Riches in Store for Superstars of Research - If Some Current Trends Continue, the Answer Is Yes by Pendlebury,David,A. (Reprinted from the Scientist, Vol 7, Pg 1, ,1993)", CURRENT CONTENTS,1993, Vol 29, Iss JUL, pp 3-8

Garfield-E, "Women in Science .1. The Productivity Puzzle - Long,J,Scott on Why Women Biochemists Publish Less Than Men - An Introduction to Measures of Sex-Differences in Scientific Productivity by Long,J,Scott (Reprinted from Social Forces, Vol 71, Pg 159-178, ,1992)", CURRENT CONTENTS,1993, Vol 9, Iss MAR, pp 3-13

Garfield-E, "Women in Science .2. The Impact Enigma - Long,J.,Scott on Why Women Biochemists Papers Are Cited More Than Mens - Introduction to Measures of Sex-Differences in Scientific Productivity by Long,J.Scott (Reprinted from Social Forces, Vol 71, Pg 159-178, ,1992)", CURRENT CONTENTS,1993, Vol 11, Iss MAR, pp 3-13

Garfield-E Sher-IH, "Keywords-Plus(TM) - Algorithmic Derivative Indexing", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 5, pp 298-299

Garfield-E Small-H, "Moravcsik,Michael,J. - Multidimensional Scholar and Hero of Third-World Science", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 19-24

Garfield-E Welljamsdorof-A, "The Microbiology Literature - Languages of Publication and Their Relative Citation Impact (Reprinted from Fems Microbiology Letters, Vol 100, Pg 33-37, ,1992)", CURRENT CONTENTS,1992, Vol 47, Iss NOV, pp 6-10

Garfield-E Welljamsdorof-A, "The Microbiology Literature - Languages of Publication and Their Relative Citation Impact", FEMS MICROBIOLOGY LETTERS,1992, Vol 100, Iss 1-3, pp 33-37

Garfield-E Welljamsdorof-A, "Citation Data - Their Use as Quantitative Indicators for Science and Technology Evaluation and Policy-Making (Reprinted from Science and Public-Policy, Vol 19, Pg 321-327, ,1992)", CURRENT CONTENTS,1992, Vol 49, Iss DEC, pp 5-13

Garfield-E Welljamsdorof-A, "Of Nobel Class - A Citation Perspective on High-Impact Research Authors", THEORETICAL MEDICINE,1992, Vol 13, Iss 2, pp 117-135

Garfield-E Welljamsdorof-A, "Of Nobel Class - A Citation Perspective on High-Impact Research Authors .2. (Reprinted from Theoretical Medicine, Vol 13, Pg 117, ,1992)", CURRENT CONTENTS,1992, Vol 35, Iss AUG, pp 4-12

Garfunkel-JM, "Errors in Citations in Foreign-Languages - Reply", JOURNAL OF PEDIATRICS,1993, Vol 123, Iss 2, pp 336-336

Garg-KC Dutt-B, "Bibliometrics of Indian Science as Reflected Through Science-Citation-Index", JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH,1992, Vol 51, Iss 4, pp 329-340

Garg-KC Karki-MMS, "Bibliometrics of Research Communications of Insa Fellows", JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH,1992, Vol 51, Iss 12, pp 929-935

Garg-KC Sharma-P, "Solar Power Research - A Scientometric Study of World Literature", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 147-157

Garg-KC Sharma-P Sharma-L, "Bradford Law in Relation to the Evolution of a Field - A Case-Study of Solar Power Research", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 145-156

Garner-DM, "Self-Report Measures for Eating Disorders - A Citation-Classic Commentary on the Eating Attitudes Test - An Index of the Symptoms of Anorexia-Nervosa by Garner,D.M., and Garfinkel,P.E., and Development and Validation of a Multidimensional Eating Disorder Inventory for Anorexia-Nervosa and Bulimia by Garner,D.M., Olmsted,M.P., and Polivy,J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 8, pp 8-8

Garnick-DW Lawthers-AG Palmer-RH Moentmann-SJR Fowles-J Weiner-JP, "A Computerized System for Reviewing Medical Records from Physicians Offices", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT,1994, Vol 20, Iss 12, pp 679-694

Garrison-HH Herman-SS Lipton-JA, "Measuring Characteristics of Scientific-Research - A Comparison of Bibliographic and Survey Data", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 359-370

Gaspar-R, "Density-Dependent Exchange Potential and the Many-Electron Schrodinger-Equation - A Citation-Classic Commentary on on an Approximation of H-F Potentials Through a Universal Potential Function by Gaspar,R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 38, pp 8-8

Gatten-JN, "Scholarly Communication and Bibliometrics, by C.L. Borgman", COLLEGE & RESEARCH LIBRARIES,1991, Vol 52, Iss 5, pp 481-483

Gavaghan-H, "Cautious Welcome to NIH Peer-Review Reforms", NATURE,1994, Vol 369, Iss 6478, pp 269-269

Gavaghan-H, "Changes Urged in NIH Peer-Review Process", NATURE,1994, Vol 372, Iss 6503, pp 209-209

Gavaghan-H, "Peer-Review - NIH Urged to Streamline Bids", NATURE,1994, Vol 370, Iss 6486, pp 170-171

Gaynes-RP Solomon-S, "Improving Hospital-Acquired Infection-Rates - The CDC Experience", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT 1996, Vol 22, Iss 7, pp 457-467

Gee-H, "UK Systematic Biology - Peers Slam Peer-Review", NATURE,1992, Vol 355, Iss 6360, pp 488-488

Geertz-C, "Change Without Progress in a Wet Rice Culture - A Citation-Classic Commentary on Agricultural Involution - The Processes of Ecological Change in Indonesia by Geertz,C.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 12, pp 8-8

Gehlhar-CG Gehlhar-MJ, "Declining Aid to Agricultural-Research - Impacts Using Global Trade Analysis", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1994, Vol 76, Iss 5, pp 1243-1243

Geisler-E, "Integrated Figure of Merit of Public-Sector Research Evaluation", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 379-395

Geisler-E, "Key Output Indicators in Performance Evaluation of Research-and-Development Organizations", TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE,1994, Vol 47, Iss 2, pp 189-203

Geller-SE Burns-LR Brailer-DJ, "The Impact of Nonclinical Factors on Practice Variations - The Case of Hysterectomies", HEALTH SERVICES RESEARCH 1996, Vol 30, Iss 6, pp 729-750

Gelles-RJ, "Family Sexual Abuse - Frontline Research and Evaluation, by M.Q. Patton", CONTEMPORARY PSYCHOLOGY,1993, Vol 38, Iss 6, pp 611-612

Genest-J, "A Collaboration on Hypertension Research - A Citation-Classic Commentary on the Heart and the Atrial-Natriuretic-Factor by Cantin,M., and Genest,J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 32, pp 10-10

Georgiev-GP, "Structure of Nuclear HnRNA-Protein Particles - A Citation-Classic Commentary on Structural Organization of Nuclear-Complexes Containing DNA-Like RNA by Samarina,O.P., Lukanidin,E.M., Molnar,J., and Georgiev,G.P.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 32, pp 8-8

Georgiev-GP, "Structure of Nuclear HnRNA-Protein Particles - A Citation-Classic Commentary on Structural Organization of Nuclear-Complexes Containing DNA-Like RNA by Samarina,O.P., Lukanidin,E.M., Molnar,J., and Georgiev,G.P.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 32, pp 8-8

Gerischer-H, "Electrochemical Solar-Cells Are Schottky-Barrier Devices - A Citation-Classic Commentary on Electrochemical Photo and Solar-Cells - Principles and Some Experiments by Gerischer,H.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 18, pp 10-10

Gerischer-H, "Photodecomposition of Semiconductors - A Thermodynamic Approach - A Citation-Classic Commentary on the Stability of Semiconductor Electrodes Against Photodecomposition by Gerischer,H.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 20, pp 10-10

Gibbs-J Young-RC Smith-GP, "Gut Hormones and Satiation - A Citation-Classic Commentary on Cholecystokinin Decreases Food-Intake in Rats by Gibbs,J., Young,R.C., and Smith,G.P.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 26, pp 8-8

Gibbs-JC Potter-GB Barriga-AQ Liau-AK, "Developing the Helping Skills and Prosocial Motivation of Aggressive Adolescents in Peer Group Programs", AGGRESSION AND VIOLENT BEHAVIOR 1996, Vol 1, Iss 3, pp 283-305

Gibson-B Werner-C, "Airport Waiting Areas as Behavior Settings - The Role of Legibility Cues in Communicating the Setting Program", JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY,1994, Vol 66, Iss 6, pp 1049-1060

Gidez-LI, "The Peer-Review Process - Strengths and Weaknesses - A Survey of Attitudes, Perceptions, and Expectations", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 75-85

Gilbert-JR Williams-ES Lundberg-GD, "Is There Gender Bias in Jamas Peer-Review Process", JAMA-JOURNAL OF THE AMERICAN MEDICAL

ASSOCIATION,1994, Vol 272, Iss 2, pp 139-142
Gillett-R, "Management of Medical-Research - MRC Selectively Criticizes Peer-Review", BRITISH MEDICAL JOURNAL,1993, Vol 307, Iss 6898, pp 264-265
Gillett-R, "Pitfalls in Assessing Research Performance by Grant Income", SCIENTOMETRICS,1991, Vol 22, Iss 2, pp 253-263
Gillett-R Harrow-J, "Prescriptions for Medical-Research .2. Is Medical-Research Well-Served by Peer-Review", BRITISH MEDICAL JOURNAL,1993, Vol 306, Iss 6893, pp 1672-1675
Gilman-LB, "Evaluating Research Library Collections in Psychology - Beyond the Conspectus", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1991, Vol 10, Iss 2, pp 27-56
Gingiss-PL, "Peer Coaching - Building Collegial Support for Using Innovative Health-Programs", JOURNAL OF SCHOOL HEALTH,1993, Vol 63, Iss 2, pp 79-85
Giordano-R, "Institutional Change and Regeneration - A Biography of the Computer-Science Department at the University-of-Manchester", IEEE ANNALS OF THE HISTORY OF COMPUTING,1993, Vol 15, Iss 3, pp 55-62
Giorgi-EP, "Long-Term Analysis of Citation Counts at the Microlevel", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 375-386
Gisvold-SE, "What Is Happening to the Quality of Research - And How Can Quality Be Measured", ACTA ANAESTHESIOLOGICA SCANDINAVICA,1995, Vol 39, Iss 1, pp 1-2
Giuliani-G Marazzini-P, "The Italian Physics Community and the Crisis of Classical Physics - New Radiations, Quanta and Relativity (1896-1925)", ANNALS OF SCIENCE,1994, Vol 51, Iss 4, pp 355-390
Gjermo-P, "Fighting Plaque - A Citation-Classic Commentary on the Plaque-Inhibiting Capacity of 11 Antibacterial Compounds by Gjermo,P., Baastad,K.L., and Rolla,G.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 20, pp 8-8
Glanzel-W, "A Bibliometric Approach to Social-Sciences, National Research Performances in 6 Selected Social-Science Areas, 1990-1992", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 291-307
Glanzel-W, "On Some Stopping-Times of Citation Processes - From Theory to Indicators", INFORMATION PROCESSING & MANAGEMENT,1992, Vol 28, Iss 1, pp 53-60
Glanzel-W, "The Need for Standards in Bibliometric Research and Technology", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 167-176
Glanzel-W Czerwon-HJ, "A New Methodological Approach to Bibliographic Coupling and Its Application to the National, Regional and Institutional Level", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 195-221
Glanzel-W Katz-S Moed-H Schoepflin-U, "Proceedings of the Workshop on Bibliometric Standards - Rosary-College, River-Forest, Illinois (USA) Sunday, June 11, 1995", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 165-166
Glanzel-W Kretschmer-H, "Selected Papers Presented at the 4th International-Conference on Bibliometrics, Informetrics and Scientometrics - In Memory of Price,Derek,John,Desolla (1922-1983) September 11-15, ,1993, Berlin (Germany) - Preface", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 5-6
Glanzel-W Schoepflin-U, "Little Scientometrics, Big

Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 375-384

Glanzel-W Schoepflin-U, "A Stochastic-Model for the Aging of Scientific Literature", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 49-64

Glanzel-W Schoepflin-U, "A Bibliometric Study on Aging and Reception Processes of Scientific Literature", JOURNAL OF INFORMATION SCIENCE,1995, Vol 21, Iss 1, pp 37-53

Glanzel-W Schubert-A, "Predictive Aspects of a Stochastic-Model for Citation Processes", INFORMATION PROCESSING & MANAGEMENT,1995, Vol 31, Iss 1, pp 69-80

Glanzel-W Schubert-A, "A Characterization of Scientometric Distributions Based on Harmonic Means", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 81-96

Glanzel-W Schubert-A, "Some Facts and Figures on Highly Cited Papers in the Sciences, 1981-1985", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 373-380

Glanzel-W Winterhager-M, "International Collaboration of 3 East European Countries with Germany in the Sciences, 1980-1989", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 219-227

Glass-CJ Hyndman-NS Mckillop-DG, "UK Universities - A Time-Series Study of Economies of Scale and Scope in the Context of the Research Assessment Exercises", PUBLIC MONEY & MANAGEMENT 1996, Vol 16, Iss 4, pp 59-64

Glass-JC Mckillop-DG Hyndman-N, "Efficiency in the Provision of University Teaching andResearch - An Empirical-Analysis of UK Universities", JOURNAL OF APPLIED ECONOMETRICS,1995, Vol 10, Iss 1, pp 61-72

Glaze-WH, "We Need Solid Peer-Review", ENVIRONMENTAL SCIENCE & TECHNOLOGY 1996, Vol 30, Iss 4, pp A145-A145

Gleason-JM, "Questionable Validity of Poisson Assumptions in a Combined Loglinear MDs Mapping Model", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 1, pp 57-59

Gleditsch-NP, "The Most-Cited Articles in Jpr", JOURNAL OF PEACE RESEARCH,1993, Vol 30, Iss 4, pp 445-449

Glendinning-S, "Analytical and Continental Philosophy", FILOSOFICKY CASOPIS 1996, Vol 44, Iss 2, pp 257-276

Glogoff-S, "Guardians of Science - Fairness and Reliability of Peer-Review, by H.D. Daniel", LIBRARY QUARTERLY,1994, Vol 64, Iss 4, pp 477-478

Godin-B, "Research and the Practice of Publication in Industries", RESEARCH POLICY 1996, Vol 25, Iss 4, pp 587-606

Godin-B Ippersiel-MP, "Scientific Collaboration at the Regional Level - The Case of a Small Country", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 59-68

Godin-G Kok-G, "The Theory of Planned Behavior - A Review of Its Applications to Health-Related Behaviors", AMERICAN JOURNAL OF HEALTH PROMOTION 1996, Vol 11, Iss 2, pp 87-98

Goedeken-EA Herubel-JPVM, "Periodical Dispersion in American History - Observations on Article Bibliographies from the Journal-of-American-History", SERIALS LIBRARIAN 1995, Vol 27, Iss 1, pp 59-74

Goh-CH Holsapple-CW Johnson-LE Tanner-J, "An

Empirical-Assessment of Influences on Pom Research", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 3, pp 337-345

Gold-T, "The Nature of Pulsars - A Citation-Classic Commentary on Rotating Neutron-Stars as the Origin of the Pulsating Radio-Sources by Gold,T., and Rotating Neutron-Stars and the Nature of Pulsars by Gold,T.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 8, pp 8-9

Goldman-RL, "The Reliability of Peer Assessments - A Metaanalysis", EVALUATION & THE HEALTH PROFESSIONS,1994, Vol 17, Iss 1, pp 3-21

Goldstein-H Thomas-S, "Using Examination Results as Indicators of School and College Performance", JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES A- STATISTICS IN SOCIETY 1996, Vol 159, Iss P1, pp 149-163

Gomez-I Bordons-M Fernandez-MT Mendez-A, "Coping with the Problem of Subject Classification Diversity", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 223-235

Gonatas-NK, "Tracing Axonal-Transport - A Citation-Classic Commentary on Superior Sensitivity of Conjugates of Horseradish-Peroxidase with Wheat-Germ-Agglutinin for Studies of Retrograde Axonal-Transport by Gonatas,N.K., Harper,C., Mizutani,T., and Gonatas,J.O.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 36, pp 8-8

Gonda-K Kakizaki-F, "Research, Technology and Development Evaluation - Developments in Japan", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 375-389

Goode-CJ Blegen-MA, "Development and Evaluation of a Research-Based Management Intervention - A Recognition Protocol", JOURNAL OF NURSING ADMINISTRATION,1993, Vol 23, Iss 4, pp 61-66

Goodman-SN Berlin-J Fletcher-SW Fletcher-RH, "Manuscript Quality Before and After Peer-Review and Editing at Annals of Internal-Medicine", ANNALS OF INTERNAL MEDICINE,1994, Vol 121, Iss 1, pp 11-21

Goodwin-JF, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 421-421

Goovaerts-P, "Comparative Performance of Indicator Algorithms forModeling Conditional-Probability Distribution-Functions", MATHEMATICAL GEOLOGY,1994, Vol 26, Iss 3, pp 389-411

Gordon-JD, "The Bluebook, by A, Uniform, System, Of, Citation", MICHIGAN LAW REVIEW,1992, Vol 90, Iss 6, pp 1698-1704

Gordon-RA, "Impact of Ingratiation on Judgments and Evaluations - A Metaanalytic Investigation", JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY 1996, Vol 71, Iss 1, pp 54-70

Gordon-RA Vicari-PJ, "Eminence in Social-Psychology - A Comparison of Textbook Citation, Social-Sciences Citation Index, and Research Productivity Rankings", PERSONALITY AND SOCIAL PSYCHOLOGY BULLETIN,1992, Vol 18, Iss 1, pp 26-38

Gore-SM Bird-AG Ross-AJ, "Prison Rights - Mandatory Drugs Tests and Performance Indicators for Prisons", BRITISH MEDICAL JOURNAL 1996, Vol 312, Iss 7043, pp 1411-1413

Gorman-CC, "Cat - An Easy Assay for Gene-Expression - A Citation-Classic Commentary on Recombinant Genomes Which Express Chloramphenicol Acetyltransferase in Mammalian-Cells by Gorman,C.M., Moffat,L.F., and Howard,B.H.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 22, pp 8-8

Gorman-DM, "Etiologic Theories and the Primary Prevention of Drug-Use", JOURNAL OF DRUG ISSUES 1996, Vol 26, Iss 2, pp 505-520

Gorman-ME, "Replication, Reliability and Peer-Review - A Case-Study", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 149-149

Gottlieb-MS, "AIDS - The Discovery - A Citation-Classic Commentary on Pneumocystis-Carinii Pneumonia and Mucosal Candidiasis in Previously Healthy Homosexual Men - Evidence of a New Acquired Cellular Immunodeficiency by Gottlieb,M.S., Schroff,R., Schanker,H.M., Weisman,J.D., Fan,P.T., Wolf,R.A. and Saxon,A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 30, pp 8-8

Gould-D Udry-E, "Psychological Skills for Enhancing Performance - Arousal Regulation Strategies", MEDICINE AND SCIENCE IN SPORTS AND EXERCISE,1994, Vol 26, Iss 4, pp 478-485

Gowans-JL, "Small Lymphocytes Initiate Immune-Responses - A Citation-Classic Commentary on the Fate of Parental Strain Small Lymphocytes in F1-Hybrid Rats by Gowans,J.L.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 2, pp 8-8

Goza-AB Ricketts-RW Perkins-TS, "The Social Validity of an Argument Supporting a Ban on Aversive Procedures", JOURNAL OF INTELLECTUAL DISABILITY RESEARCH,1993, Vol 37, Iss OCT, pp 449-458

Graf-J Malcomb-L, "Identifying Unidentified United-States-Government Reports", JOURNAL OF GOVERNMENT INFORMATION,1994, Vol 21, Iss 2, pp 105-128

Graham-FL, "Cell-Line Transformation - A Citation-Classic Commentary on Characteristics of a Human Cell-Line Transformed by DNA from Human Adenovirus Type-S by Graham,F.L., Smiley,J., Russell,W.C., and Nairn,R.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 8, pp 8-8

Graham-J, "Oral-History in Social-Work - Research, Assessment, and Intervention, by R.R. Martin", SOCIAL SERVICE REVIEW 1996, Vol 70, Iss 3, pp 497-498

Granovsky-YV Luibimova-TN Murashova-TI Myatlev-VD, "Information-Based Evaluation of the Quality of Doctoral Theses", SCIENTOMETRICS,1992, Vol 23, Iss 3, pp 361-376

Grant-JB Hayes-RP Pates-RD Elward-KS Ballard-DJ, "HCFA Health-Care Quality Improvement Program - The Medical Informatics Challenge", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION 1996, Vol 3, Iss 1, pp 15-26

Grant-R Koop-R, "Canadian Traditions and Directions in Information-Systems Research", REVUE CANADIENNE DES SCIENCES DE L ADMINISTRATION-CANADIAN JOURNAL OF ADMINISTRATIVE SCIENCES,1995, Vol 12, Iss 1, pp 38-55

Grant-WS, "Evaluating Researcher Performance by Citation Analysis", SOUTH AFRICAN JOURNAL OF SCIENCE,1991, Vol 87, Iss 11-12, pp 557-560

Grantham-JJ, "Peer-Review of Manuscripts - Right and Responsibility", JOURNAL OF THE AMERICAN SOCIETY OF NEPHROLOGY1990,

Vol 1, Iss 2, pp 125-126

Gray-D Saggers-S Drandich-M Wallam-D Plowright-P, "Evaluating Government Health and Substance-Abuse Programs for Indigenous Peoples - A Comparative Review", AUSTRALIAN JOURNAL OF PUBLIC HEALTH 1995, Vol 19, Iss 6, pp 567-572

Grayson-M, "Superfund Citations = Supermess", HOSPITALS,1993, Vol 67, Iss 1, pp 4-4

Green-MB, "The Consistency of Superstring Theory - A Citation-Classic Commentary on Green,M.B., Schwarz,J.H. Anomaly Cancellations in Supersymmetric D=10 Gauge-Theory and Superstring Theory by Green,M.B., Schwarz,J.H.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 28, pp 8-8

Green-PE, "Methodology in Consumer Research - A Citation-Classic Commentary on Consumer Research - Issues and Outlook by Green,P.E. and Srinivasan,V.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 14, pp 10-10

Green-SA, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 184-184

Greene-NM, "Peer-Reviewed Anesthesiology Journals and Research - Reply", ANESTHESIA AND ANALGESIA,1992, Vol 75, Iss 1, pp 156-156

Greene-R, "Is There an Alternative to Peer-Review", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 149-149

Greenfield-LJ Proctor-MC, "Attitudes Toward Retirement - A Survey of the American-Surgical-Association", ANNALS OF SURGERY,1994, Vol 220, Iss 3, pp 382-390

Greenwald-AG Schuh-ES, "An Ethnic Bias in Scientific Citations", EUROPEAN JOURNAL OF SOCIAL PSYCHOLOGY,1994, Vol 24, Iss 6, pp 623-639

Greeson-LE, "Cultural Ethnocentrism and Imperialism in Citations of American and Scandinavian Psychological-Research", INTERNATIONAL JOURNAL OF PSYCHOLOGY,1991, Vol 26, Iss 2, pp 262-268

Greeson-LE, "Husen,Torsten - A Case of Ethnocentrism in United-States Educational-Research", INTERCHANGE,1994, Vol 25, Iss 3, pp 241-259

Gregory-K, "Peer-Review - A Report to the Advisory-Board-for-the-Research-Councils from the Working Group on Peer-Review, Abrc, November 1990", AREA,1991, Vol 23, Iss 4, pp 364-366

Gregory-KJ, "The ,1992 Ufc Research Assessment Exercise for Geography", JOURNAL OF GEOGRAPHY IN HIGHER EDUCATION,1993, Vol 17, Iss 2, pp 170-174

Greschner-M Rassweiler-JJ Weber-A Alken-P, "New Methods of Searching for Medical Literature - Comparison of 2 Systems, Implementation and User Reactions in a Urologic Department", UROLOGIA INTERNATIONALIS 1996, Vol 57, Iss 1, pp 1-4

Gresty-MA, "Peer-Review and Anonymity", NEURO-OPHTHALMOLOGY 1995, Vol 15, Iss 6, pp 281-282

Griffith-BC, "Little Scientometrics, Little Scientometrics, Little Scientometrics, Little Scientometrics ... and So on and So on", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 487-493

Griffiths-C, "Citation Analyses - Further Implications", SOUTH AFRICAN JOURNAL OF SCIENCE,1992, Vol 88, Iss 5, pp 248-249

Griggs-RA Jackson-SL, "40 Years of Introductory Psychology - An Analysis of the First 10 Editions of Hilgard Et Al Textbook", TEACHING OF PSYCHOLOGY 1996, Vol 23, Iss 3, pp 144-150

Grigsby-RK Roof-HL, "Federal-Policy for the Protection of Human-Subjects - Applications to Research on Social-Work-Practice", RESEARCH ON SOCIAL WORK PRACTICE,1993, Vol 3, Iss 4, pp 448-461

Griliches-Z, "Distributed Lags - A Citation-Classic Commentary on Distributed Lags - A Survey by Griliches,Z.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 38, pp 8-8

Griliches-Z, "National-Science-Foundation Grants for Economics - Reply", JOURNAL OF ECONOMIC PERSPECTIVES,1994, Vol 8, Iss 1, pp 203-205

Griliches-Z, "Patent Statistics As Economic Indicators - A Survey", JOURNAL OF ECONOMIC LITERATURE1990, Vol 28, Iss 4, pp 1661-1707

Griliches-Z, "Productivity, Research-and-Development, and the Data Constraint", AMERICAN ECONOMIC REVIEW,1994, Vol 84, Iss 1, pp 1-23

Griliches-Z, "Sources of Agricultural Economic-Growth and Productivity - Discussion", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 74, Iss 3, pp 762-763

Griliches-Z, "The Search for Research-and-Development Spillovers", SCANDINAVIAN JOURNAL OF ECONOMICS,1992, Vol 94, Iss S, pp S29-S47

Griliches-Z, "The Discovery of the Residual - A Historical Note", JOURNAL OF ECONOMIC LITERATURE 1996, Vol 34, Iss 3, pp 1324-1330

Griliches-Z Regev-H, "Firm Productivity in Israeli Industry - 1979-1988", JOURNAL OF ECONOMETRICS,1995, Vol 65, Iss 1, pp 175-203

Grimes-DA Schulz-KF, "Methodology Citations and the Quality of Randomized Controlled Trials in Obstetrics and Gynecology", AMERICAN JOURNAL OF OBSTETRICS AND GYNECOLOGY 1996, Vol 174, Iss 4, pp 1312-1315

Grob-K, "Preparation of Capillary Columns for Gas-Chromatography -A Citation-Classic Commentary on Deactivation of Glass-Capillary Columns by Silylation by Grob,K., Grob,G. and Grob,K.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 22, pp 10-10

Grover-V Segars-AH Simon-SJ, "An Assessment of Institutional Research Productivity in MIS", DATA BASE,1992, Vol 23, Iss 4, pp 5-9

Gruber-KA, "An Endogenous Digitalis-Like Substance - A Citation-Classic Commentary on Endogenous Digitalis-Like Substance in Plasma of Volume-Expanded Dogs by Gruber,K.A., Whitaker,J.M. and Buckalew,V.M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 2, pp 9-9

Grunze-H Walden-J Wolf-R Berger-M, "Combined Treatment with Lithium and Nimodipine in a Bipolar-I Manic Syndrome", PROGRESS IN NEURO-PSYCHOPHARMACOLOGY & BIOLOGICAL PSYCHIATRY 1996, Vol 20, Iss 3, pp 419-426

Grupp-H Hinze-S, "International Orientation, Efficiency of and Regard for Research in East and West-Germany - A Bibliometric Investigation of Aspects of Technology Genesis in the United Germany", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 83-113

Grupp-H Schmoch-U Kuntze-U, "Patents As Potential Indicators of the Utility of EC Research Programs", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 417-445

Guardiola-E Sanchezcarbonell-J, "Analysis of the Spanish Scientific Production on Drug Dependency", MEDICINA CLINICA,1993, Vol 101, Iss 10, pp 368-371

Gubler-U, "A Simple and Very Efficient Method for Generating cDNALibraries - A Citation-Classic Commentary on a Simple and Very Efficient Method for Generating cDNA Libraries by Gubler,U., and Hoffman,B.J.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 20, pp 8-8

Guedea-LJ, "Get-A-Ref V-4.3 - Not an Ordinary Citation Management Program", DATABASE-THE MAGAZINE OF DATABASE REFERENCE AND REVIEW,1991, Vol 14, Iss 2, pp 65-74

Guiraudon-G, "The Circle of the Heart - A Citation-Classic Commentary on Encircling Endocardial Ventriculotomy - A New Surgical-Treatment for Life-Threatening Ventricular Tachycardias Resistant to Medical-Treatment Following Myocardial-Infarction by Guiraudon,G., Fontaine,G., Frank,R., Escande,G., Etievent,P., and Cabrol,C.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 24, pp 8-8

Gupta-AP, "The Peer-Review Process, Multiple Publications, and the Overcrowded by-Line - Roles of the Editor, Reviewer, and Author", INTERNATIONAL JOURNAL OF INSECT MORPHOLOGY & EMBRYOLOGY 1996, Vol 25, Iss 1-2, pp 19-24

Gupta-BM Karisiddappa-CR, "Author Productivity Patterns in Theoretical Population-
Genetics (1900-1980)", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 19-41

Gupta-DK, "Collaborative Research Trend in Exploration Geophysics", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 287-296

Gupta-VK, "Should Intellectual Property Be Disseminated by Forwarding Rejected Letters Without Permission", JOURNAL OF MEDICAL ETHICS 1996, Vol 22, Iss 4, pp 243-244

Gutierrez-G Guiscafre-H Bronfman-M Walsh-J Martinez-H Munoz-O, "Changing Physician Prescribing Patterns - Evaluation of an Educational Strategy for Acute Diarrhea in Mexico-City", MEDICAL CARE,1994, Vol 32, Iss 5, pp 436-446

Guzzo-RA Dickson-MW, "Teams in Organizations - Recent Research on Performance and Effectiveness", ANNUAL REVIEW OF PSYCHOLOGY 1996, Vol 47, pp 307-338

Haaga-DAF, "Peer-Review of Term Papers in Graduate Psychology Courses", TEACHING OF PSYCHOLOGY,1993, Vol 20, Iss 1, pp 28-32

Habashi-F, "Citation Missed", CIM BULLETIN 1996, Vol 89, Iss 998, pp 8-8

Hackerman-N, "Peerless Science - Peer-Review and United-States Science Policy, by D.E. Chubin, E.J. Hackett", JOURNAL OF HIGHER EDUCATION,1992, Vol 63, Iss 3, pp 343-344

Hackett-EJ, "Scholarly Communication and Bibliometrics, by C.L. Borgman", CONTEMPORARY SOCIOLOGY-AN INTERNATIONAL JOURNAL OF REVIEWS,1992, Vol 21, Iss 1, pp 142-143

Haddad-JG, "Specific Plasma Vitamin-D Metabolite Measurements - A Citation-Classic Commentary on Competitive-Protein-Binding Radioassay for 25-Hydroxycholecalciferol byHaddad,J.G., and Chyu,K.J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 40, pp 8-8

Hadley-TD, "Qualitative Evaluation and Research Methods, 2nd Edition, by M.Q. Patton", JOURNAL OF COLLEGE STUDENT DEVELOPMENT,1991, Vol 32, Iss 5, pp 474-476

Hadorn-DC Baker-D, "Development of the Ahcpr-Sponsored Heart-Failure Guideline - Methodologic and Procedural Issues", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT,1994, Vol 20, Iss 10, pp 539-547

Hagan-TA Finnegan-LP Nelsonzlupko-L, "Impediments to Comprehensive Treatment Models for Substance-Dependent Women - Treatment and Research Questions", JOURNAL OF PSYCHOACTIVE DRUGS,1994, Vol 26, Iss 2, pp 163-171

Haigh-R, "The Aging Process - A Challenge for Design", APPLIED ERGONOMICS,1993, Vol 24, Iss 1, pp 9-14

Haitun-SD, "The Problem of Indicator-Latent Relationship in Metric Models .2. Metric Models with a Priori Latent Assignment", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 221-235

Haitun-SD, "The Problem of Indicator-Latent Relationship in Metric Models .1. Statement and General-Solution", SCIENTOMETRICS,1992, Vol 23, Iss 2, pp 335-351

Hall-DH, "The Science-Industry Interface - Correlation of Time-Series of Indicators and Their Spectra, and Growth-Models in the Nuclear-Fuels Industry", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 237-280

Hall-DH, "The Science-Industry Interface in the Petroleum-Industry - Correlation of Time-Series of Indicators and Their Spectra, and Growth Modeling", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 237-286

Hallett-MA Rogers-R, "The Push for Truth in Sentencing - Evaluating Competing Stakeholder Constructions - The Case for Contextual Constructionism in Evaluation Research", EVALUATION AND PROGRAM PLANNING,1994, Vol 17, Iss 2, pp 187-196

Halliwell-B, "Transition-Metal Ions and Oxidative Damage - A Citation-Classic Commentary on Superoxide-Dependent Formation of Hydroxyl Radicals in the Presence of Iron Chelates by Halliwell,B. and Oxygen-Toxicity, Oxygen Radicals, Transition-Metals and Disease by Halliwell,B. and Gutteridge,J.M.C.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 2, pp 9-9

Halpern-J, "The Measurement of Quality of Care in the Veterans-Health-Administration", MEDICAL CARE 1996, Vol 34, Iss 3, pp MS55-MS68

Hamade-SN, "Characteristics of the Literature Used by Arab Authors in Library and Information-Science - A Bibliometric Study", INTERNATIONAL INFORMATION & LIBRARY REVIEW,1994, Vol 26, Iss 3, pp 139-150

Hamilton-PB, "Justification for Mycotoxin Research - A Citation-Classic Commentary on Aflatoxicosis in the Broiler Chicken by Smith,J.W., Hamilton,P.B.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 46, pp 10-10

Hammerschmidt-DE, "The Vagaries of Peer-Review - A New Study and Our Experience", JOURNAL OF LABORATORY AND CLINICAL MEDICINE,1994, Vol 124, Iss 2, pp 146-148

Hammerschmidt-DE Gross-AG, "The Problem of Biomedical Fraud -

A Model for Retrospective and Prospective Action", JOURNAL OF SCHOLARLY PUBLISHING 1995, Vol 27, Iss 1, pp 3-11

Hammond-LS Devine-SD, "The New-Zealand Experience of a Comprehensive Fully Costed Science Funding System", HIGHER EDUCATION,1994, Vol 28, Iss 1, pp 119-127

Hamon-M, "From Painting to Binding - A Citation-Classic Commentary on Characteristics of Central 5-HT Receptors and Their Adaptive-Changes Following Intracerebral 5,7-Dihydroxytryptamine Administration in the Rat by Nelson,D.L., Herbet,A., Bourgoin,S., Glowinski,J. and Harmon,M.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 12, pp 9-9

Hancock-T Lane-J Ray-R Glennon-D Armstrong-JS Mahoney-MJ Hubbard-R Collopy-F, "The Ombudsman - Factors Influencing Academic Research Productivity - A Survey of Management Scientists", INTERFACES,1992, Vol 22, Iss 5, pp 26-38

Hancocks-S, "Audit and Peer-Review for Dentists", BRITISH MEDICAL JOURNAL,1991, Vol 303, Iss 6800, pp 433-433

Handwerker-HO, "The Quest for Spinal Pain Neurons - A Citation-Classic Commentary on Segmental and Supraspinal Actions on Dorsal Horn Neurons Responding to Noxious and Nonnoxious Skin Stimuli by Handwerker,H.O., Iggo,A. and Zimmermann,M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 6, pp 10-10

Hanish-C Horan-JJ Keen-B Stpeter-CC Ceperich-SD Beasley-JF, "The Scientific Stature of Counseling Psychology Training-Programs - A Still Picture of a Shifting Scene", COUNSELING PSYCHOLOGIST,1995, Vol 23, Iss 1, pp 82-101

Hannah-HW, "Peer-Review - Pros and Cons", JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION,1994, Vol 204, Iss 9, pp 1352-1353

Hansen-HB Brinch-K Henriksen-JH, "Scientific Publications from Departments of Clinical Physiology and Nuclear-Medicine in Denmark - A Bibliometric Analysis of Impact in the Years 1989-1994", CLINICAL PHYSIOLOGY 1996, Vol 16, Iss 5, pp 507-519

Hansen-JB Feldhusen-JF, "Comparison of Trained and Untrained Teachers of Gifted Students", GIFTED CHILD QUARTERLY,1994, Vol 38, Iss 3, pp 115-123

Hansen-KA, "Publication Peer-Review - An Annotated-Bibliography, by B.W. Speck", JOURNAL OF COMMUNICATION,1994, Vol 44, Iss 1, pp 52-64

Hansen-ME Mcintire-DD, "Reference Citations in Radiology - Accuracy and Appropriateness of Use in 2 Major Journals", AMERICAN JOURNAL OF ROENTGENOLOGY,1994, Vol 163, Iss 3, pp 719-723

Hara-H Chung-OH Koyama-J, "Dynamic Activation Processes Described by Generalized Random-Walks", PHYSICAL REVIEW B-CONDENSED MATTER,1992, Vol 46, Iss 2, pp 838-845

Hargens-LL Bott-DM, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1409-1409

Hargreaves-DJ Galton-MJ Robinson-S, "Teachers Assessments of Primary Childrens Classroom Work in the Creative Arts", EDUCATIONAL RESEARCH 1996, Vol 38, Iss 2, pp 199-211

Harmon-JE, "An Analysis of 50 Citation Superstars from the Scientific Literature", JOURNAL OF TECHNICAL WRITING AND

COMMUNICATION,1992, Vol 22, Iss 1, pp 17-37

Harmon-JE, "Current-Contents of Theoretical Scientific Papers", JOURNAL OF TECHNICAL WRITING AND COMMUNICATION,1992, Vol 22, Iss 4, pp 357-375

Harper-JA, "A Bibliometric Profile of the Canadian-Journal-of-Agricultural-Economics", CANADIAN JOURNAL OF AGRICULTURAL ECONOMICS-REVUE CANADIENNE D ECONOMIE RURALE,1991, Vol 39, Iss 3, pp 503-513

Harper-JA, "Citation Accuracy in the Canadian-Journal-of-Plant-Science", CANADIAN JOURNAL OF PLANT SCIENCE,1992, Vol 72, Iss 2, pp 487-488

Harrigan-TP, "Peer-Review Reconsidered", TECHNOLOGY REVIEW,1992, Vol 95, Iss 3, pp 7-7

Harris-G Kaine-G, "The Determinants of Research Performance - A Study of Australian University Economists", HIGHER EDUCATION,1994, Vol 27, Iss 2, pp 191-201

Harris-M, "The Intellectual Ancestry of Cultural Materialism - A Citation-Classic Commentary on the Rise of Anthropological Theory - A History of Theories of Culture by Harris,M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 16, pp 8-8

Harris-M Hartley-AL Blair-V Birch-JM Banerjee-SS Freemont-AJ Mcclure-J Mcwilliam-LJ, "Sarcomas in North-West England .1. Histopathological Peer-Review", BRITISH JOURNAL OF CANCER,1991, Vol 64, Iss 2, pp 315-320

Harrison-AE, "Productivity, Imperfect Competition and Trade Reform - Theory and Evidence", JOURNAL OF INTERNATIONAL ECONOMICS,1994, Vol 36, Iss 1-2, pp 53-73

Harsanyi-MA, "Multiple Authors, Multiple Problems Bibliometrics and the Study of Scholarly Collaboration - A Literature-Review", LIBRARY & INFORMATION SCIENCE RESEARCH,1993, Vol 15, Iss 4, pp 325-354

Harsanyi-MA Harter-SP, "Ecclesiastes Effects", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 93-96

Hart-E Bond-M, "Making Sense of Action Research Through the Use of a Typology", JOURNAL OF ADVANCED NURSING 1996, Vol 23, Iss 1, pp 152-159

Hart-RH, "Invisible-Colleges and Citation Clusters in Stocking Rate Research", JOURNAL OF RANGE MANAGEMENT,1993, Vol 46, Iss 5, pp 378-382

Harter-SP, "Colinked Descriptors - An Application of Bibliometrics to Interface Design", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 131-134

Harter-SP, "Scholarly Communication and Bibliometrics, by C.L. Borgman", JOURNAL OF DOCUMENTATION,1992, Vol 48, Iss 3, pp 333-336

Harter-SP Cheng-YR, "Co-Linked Descriptors - Improving Vocabulary Selection for End-User Searching", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 4, pp 311-325

Harter-SP Hooten-PA, "Factors Affecting Funding and Citation Rates in Information-Science Publications", LIBRARY & INFORMATION SCIENCE RESEARCH1990, Vol 12, Iss 3, pp 263-280

Harter-SP Kim-HJ, "Accessing Electronic Journals and Other E-Publications - An Empirical-Study", COLLEGE & RESEARCH LIBRARIES

1996, Vol 57, Iss 5, pp 440+

Harter-SP Nisonger-TE Weng-AW, "Semantic Relationships Between Cited and Citing Articles in Library and Information-Science Journals", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 9, pp 543-552

Hartley-AL Blair-V Harris-M Birch-JM Banerjee-SS Freemont-AJ Mcclure-J Mcwilliam-LJ, "Multiple Primary Tumors in a Population-Based Series ofPatients with Histopathologically Peer-Reviewed Sarcomas", BRITISH JOURNAL OF CANCER,1993, Vol 68, Iss 6, pp 1243-1246

Hartley-J Sydes-M Blurton-A, "Obtaining Information Accurately and Quickly - Are Structured Abstracts More Efficient", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 5, pp 349-356

Hartley-K Martin-S, "Evaluating Collaborative Programs", DEFENCE ECONOMICS,1993, Vol 4, Iss 2, pp 195-211

Hartman-RL, "The Employee Independent Contractor Employer Dilemma", JOURNAL OF COLLECTIVE NEGOTIATIONS IN THE PUBLIC SECTOR,1994, Vol 23, Iss 2, pp 115-135

Hartmann-P Bott-U Grusser-M Kronsbein-P Jorgens-V, "Effects of Peer-Review Groups on Documentation of Diabetes-Related Patient Data in Physicians Practice - Results of a Prospective Controlled-Study", DIABETOLOGIA,1994, Vol 37, Iss S1, pp A176-A176

Hartog-R, "Essential and Nonessential Drugs Marketed by the 20 Largest European Pharmaceutical Companies in Developing-Countries", SOCIAL SCIENCE & MEDICINE,1993, Vol 37, Iss 7, pp 897-904

Hartrick-G Lindsey-AE Hills-M, "Family Nursing Assessment - Meeting the Challenge of Health Promotion", JOURNAL OF ADVANCED NURSING,1994, Vol 20, Iss 1, pp 85-91

Hartt-MA Ross-B Febbraro-A Thoms-H Bauer-N Lubek-I, "Scientific Productivity of Women Social Psychologists - 3 PhD Cohorts at the University-of-Michigan", CANADIAN PSYCHOLOGY-PSYCHOLOGIE CANADIENNE,1994, Vol 35, Iss 2A, pp 170-170

Hartz-AJ Gottlieb-MS Kuhn-EM Rimm-AA, "The Relationship Between Adjusted Hospital Mortality and the Results of Peer-Review", HEALTH SERVICES RESEARCH,1993, Vol 27, Iss 6, pp 765-777

Hartz-AJ Kuhn-EM Kayser-KL Pryor-DP Green-R Rimm-AA, "Assessing Providers of Coronary Revascularization - A Method for Peer-Review Organizations", AMERICAN JOURNAL OF PUBLIC HEALTH,1992, Vol 82, Iss 12, pp 1631-1640

Harvey-JH Mulliganwebb-S, "Probing the Depths of Commonsense Psychology - A Citation-Classic Commentary on the Psychology of Interpersonal-Relations by Harvey,J.H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 20, pp 8-8

Harvey-M, "Designing and Searching a New Citations Database - Experiences with Derwents Patents Citations Index", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 46-CINF

Hattie-J, "Performance Indicators in Education", AUSTRALIAN JOURNAL OF EDUCATION1990, Vol 34, Iss 3, pp 249-276

Hattie-J Print-M Krakowski-K, "The Productivity of Australian Academics in Education", AUSTRALIAN JOURNAL OF EDUCATION,1994, Vol 38, Iss 3, pp 201-218

Hauser-GM, "Measuring Up - The Promises and Pitfalls of Performance Havemann-F, "Changing Publication Behavior of East and Central-
European Scientists and the Impact of Their Papers", INFORMATION PROCESSING & MANAGEMENT 1996, Vol 32, Iss 4, pp 489-496

Hawkes-R, "The Dot-Immunobinding Assay - A Citation-Classic Commentary on a Dot-Immunobinding Assay for Monoclonal and Other Antibodies by Hawkes,R., Niday,E., Gordon,J.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 44, pp 9-9

Hawley-LM, "Document Delivery - From Citation to Document Using Online Verification", ONLINE,1993, Vol 17, Iss 3, pp 70-&

Hay-AM, "A Peers Review of a Review of Peer-Review", AREA,1991, Vol 23, Iss 4, pp 361-364

Hayflick-L, "Discovery of the 1st Mycoplasma to Cause a Human-Disease - A Citation-Classic Commentary on Growth on Artificial Medium of an Agent Associated with Atypical Pneumonia and Its Identification as a PPLO by Chanock,R.M., Hayflick,L., and Barile,M.F.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 40, pp 8-8

Haynes-RB Sackett-DL, "Evidence-Based Medicine - Letters Pages Are Essential for Peer-Review - Reply", BRITISH MEDICAL JOURNAL 1996, Vol 312, Iss 7046, pp 1611-1611

Haynes-RB Walker-CJ Mckibbon-KA Johnston-ME Willan-AR, "Performances of 27 Medline Systems Tested by Searches with Clinical Questions", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Vol 1, Iss 3, pp 285-295

Hayward-RA Mcmahon-LF Bernard-AM, "Implicit Quality Review of General Medicine Inpatients - Peering at Peer-Review", CLINICAL RESEARCH,1992, Vol 40, Iss 2, pp A583-A583

Haywood-T Cavanaugh-JL, "Sexual Deviancy", CURRENT OPINION IN PSYCHIATRY 1996, Vol 9, Iss 6, pp 384-388

Haywood-TW Grossman-LS Kravitz-HM Wasyliw-OE, "Profiling Psychological Distortion in Alleged Child Molesters", PSYCHOLOGICAL REPORTS,1994, Vol 75, Iss 2, pp 915-927

Hazell-P King-R, "Arguments for and Against Teaching Suicide-Prevention in Schools", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY 1996, Vol 30, Iss 5, pp 633-642

Hazell-PBR, "Making Risk Programming Accessible - A Citation-Classic Commentary on a Linear Alternative to Quadratic and Semivariance Programming for Farm-Planning Under Uncertainty by Hazell,P.B.R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 36, pp 8-8

He-AW, "Language Use in Peer-Review Texts", LANGUAGE IN SOCIETY,1993, Vol 22, Iss 3, pp 403-420

Healy-AF, "Estes,William,K. - Citation", AMERICAN PSYCHOLOGIST,1992, Vol 47, Iss 7, pp 855-857

Hearne-B, "Mcelderry,Margaret,K. and the Professional Matriarchy of Heath-AC, "Genetic Influences on Alcoholism Risk - A Review of Adoption and Twin Studies", ALCOHOL HEALTH & RESEARCH WORLD 1995, Vol 19, Iss 3, pp 166-171

Heeks-P, "Teaching Information Skills - A Review of the Research and Its Impact on Education, by R. Rogers", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1994, Vol 26, Iss 3, pp 172-174

Heine-MH, "The Characterization of Text Corpora Using an Input-Output Schema for Citations", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 177-194

Heinz-LC Chubin-DE, "Science As a Process - An Evolutionary Account of the Social and Conceptual Development of Science, by D.L. Hull", INTERDISCIPLINARY SCIENCE REVIEWS1990, Vol 15, Iss 4, pp 384-386

Helander-E, "Evaluation Activities in the Nordic Countries", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 391-400

Helsby-G Saunders-M, "Taylorism, Tylerism and Performance Indicators - Defending the Indefensible", EDUCATIONAL STUDIES,1993, Vol 19, Iss 1, pp 55-77

Hemlin-S, "Scientific Quality in the Eyes of the Scientist - A Questionnaire Study", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 3-18

Hemphill-SA, "Characteristics of Conduct-Disordered Children and Their Families - A Review", AUSTRALIAN PSYCHOLOGIST 1996, Vol 31, Iss 2, pp 109-118

Henderson-A, "Research Productivity", SCIENCE 1996, Vol 271, Iss 5256, pp 1653-1654

Henderson-R Cockburn-I, "Measuring Competence - Exploring Firm Effects in Pharmaceutical Research", STRATEGIC MANAGEMENT JOURNAL,1994, Vol 15, Iss NSI, pp 63-84

Henderson-R Cockburn-I, "Scale, Scope, and Spillovers - The Determinants of Research Productivity in Drug Discovery", RAND JOURNAL OF ECONOMICS 1996, Vol 27, Iss 1, pp 32-59

Henningfield-JE Keenan-RM, "Nicotine Delivery Kinetics and Abuse Liability", JOURNAL OF CONSULTING AND CLINICAL PSYCHOLOGY,1993, Vol 61, Iss 5, pp 743-750

Henriksen-A Selmerolsen-AR, "Environmental Chemistry in Oslo - A Citation-Classic Commentary on Automatic Methods for Determining Nitrate and Nitrite in Water and Soil Extracts by Henriksen,A., and Selmerolsen,A.R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 4, pp 8-8

Hepler-PK Wayne-RO, "Calcium and Signal-Transduction in Plants - A Citation-Classic Commentary on Calcium and Plant Development by Hepler,P.K., Wayne,R.O.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 30, pp 8-8

Heppner-PP Kivlighan-DM Good-GE Roehlke-HJ Hills-HI Ashby-JS, "Presenting Problems of University Counseling-Center Clients - A Snapshot and Multivariate Classification Scheme", JOURNAL OF COUNSELING PSYCHOLOGY,1994, Vol 41, Iss 3, pp 315-324

Herbertz-H Mullerhill-B, "Quality and Efficiency of Basic Research in Molecular-
Biology - A Bibliometric Analysis of 13 Excellent Research Institutes", RESEARCH POLICY 1995, Vol 24, Iss 6, pp 959-979

Herbstein-FH, "Measuring Publications Output and Publications Impact of Faculty Members of a University Chemistry Department", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 349-373

Herdt-RW, "Research and Productivity in Asian Agriculture, by R.E. Evenson, C.E. Pray", ECONOMIC DEVELOPMENT AND CULTURAL CHANGE,1993, Vol 41, Iss 4, pp 901-903

Herman-B, "NIH Reviewers - Doing Their Best", SCIENTIST 1996,

Vol 10, Iss 3, pp 12-12

Hernon-P, "Determination of Sample-Size and Selection of the Sample - Concepts, General Sources, and Software", COLLEGE & RESEARCH LIBRARIES,1994, Vol 55, Iss 2, pp 171-179

Hersh-WR Hickam-DH Haynes-RB Mckibbon-KA, "A Performance and Failure Analysis of Saphire with a Medline Test Collection", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Vol 1, Iss 1, pp 51-60

Herubel-JPVM, "Philosophy Dissertation Bibliographies and Citations in Serials Evaluation", SERIALS LIBRARIAN,1991, Vol 20, Iss 2-3, pp 65-73

Herubel-JPVM Buchanan-AL, "Rousseau,Jean,Jacques Among the Footnotes - Mapping Interdisciplinary Research in Social-Science-Citation-Index", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1994, Vol 13, Iss 1, pp 49-57

Herubel-JPVM Buchanan-AL, "Using Ssci to Map Scholarly Influence in the Social-Sciences - Braudel and Annales Historiography", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1993, Vol 12, Iss 1, pp 45-51

Heydorn-WH Moncrief-WH, "Simultaneous Reconstruction of the Abdominal-Aorta and Cholecystectomy - A Peer-Review Perspective", WESTERN JOURNAL OF MEDICINE,1992, Vol 157, Iss 5, pp 569-571

Hicks-D, "Instrumentation, Interdisciplinary Knowledge, and Research Performance in Spin-Glass and Superfluid He-3", SCIENCE TECHNOLOGY & HUMAN VALUES,1992, Vol 17, Iss 2, pp 180-204

Hicks-D, "University-Industry Research Links in Japan", POLICY SCIENCES,1993, Vol 26, Iss 4, pp 361-395

Hicks-D Ishizuka-T Keen-P Sweet-S, "Japanese Corporations, Scientific-Research and Globalization", RESEARCH POLICY,1994, Vol 23, Iss 4, pp 375-384

Hicks-D Potter-J, "Sociology of Scientific Knowledge - A Reflexive Citation Analysis or Science Disciplines and Disciplining Science", SOCIAL STUDIES OF SCIENCE,1991, Vol 21, Iss 3, pp 459-501

Hicks-DM Isard-PA Martin-BR, "A Morphology of Japanese and European Corporate Research Networks", RESEARCH POLICY 1996, Vol 25, Iss 3, pp 359-378

Hicks-DM Katz-JS, "Where Is Science Going", SCIENCE TECHNOLOGY & HUMAN VALUES 1996, Vol 21, Iss 4, pp 379-406

Hickson-M Stacks-DW Amsbary-JH, "Active Prolific Scholars in Communication Studies - Analysis of Research Productivity .2.", COMMUNICATION EDUCATION,1993, Vol 42, Iss 3, pp 224-233

Higgins-AC, "Peerless Science - Peer-Review and United-States Science Policy, by D.E. Chubin, E.J. Hackett", SOCIAL FORCES1990, Vol 69, Iss 2, pp 634-634

Higgins-T, "Indicators of European Scientific Cohesion", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 367-381

Hilgartner-S Brandtrauf-SI, "Data Access, Ownership, and Control - Toward Empirical-Studies of Access Practices", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1994, Vol 15, Iss 4, pp 355-372

Hills-P, "Prests Experience of Evaluation", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 401-414

Hilu-KW, "Can There Be a Standardized Format for Literature Citations", BIOSCIENCE,1993, Vol 43, Iss 11, pp 779-781

Himmelstein-KJ Kumar-S, "Citation Index", JOURNAL OF BIOACTIVE AND COMPATIBLE POLYMERS 1996, Vol 11, Iss 1, pp 72-82

Hinchcliff-KW Bruce-NJ Powers-JD Kipp-ML, "Accuracy of References and Quotations in Veterinary Journals", JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION,1993, Vol 202, Iss 3, pp 397-400

Hinde-RA, "Animal Behavior - A Synthesis of Ethology and Comparative Psychology - A Citation-Classic Commentary on Animal Behavior by Hinde,R.A.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 40, pp 8-8

Hinze-S, "Bibliographical Cartography of an Emerging Interdisciplinary Discipline - The Case of Bioelectronics", SCIENTOMETRICS,1994, Vol 29, Iss 3, pp 353-376

Hinze-S Grupp-H, "Mapping of Research-and-Development Structures in Transdisciplinary Areas - New Biotechnology in Food Sciences", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 313-335

Hinze-WL, "Cyclodextrins and Separations - A Happy Marriage - A Citation-Classic Commentary on Applications of Cyclodextrins in Chromatographic Separations and Purification Methods by Hinze,W.L.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 38, pp 9-9

Hodges-S Hodges-B Meadows-AJ Beaulieu-M Law-D, "The Use of an Algorithmic Approach for the Assessment of Research Quality", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 3-13

Hodgins-M Delahunty-A, "Evaluating Programs in Social Care", IRISH JOURNAL OF PSYCHOLOGY,1994, Vol 15, Iss 4, pp 559-573

Hoffman-DL Holbrook-MB, "The Intellectual Structure of Consumer Research - A Bibliometric Study of Author Cocitations in the 1st 15 Years of the Journal of Consumer Research", JOURNAL OF CONSUMER RESEARCH,1993, Vol 19, Iss 4, pp 505-517

Hoffmann-R Dinnocenzo-JP, "Proper Benzene Citation", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 18, pp 4-4

Hogston-R, "Evaluating Quality Nursing-Care Through Peer-Review and Reflection - The Findings of a Qualitative Study", INTERNATIONAL JOURNAL OF NURSING STUDIES,1995, Vol 32, Iss 2, pp 162-172

Hohmann-H, "Effective Environmental-Policy - Consequences of Implementation and Evaluation Research - German, by G. Ueersohn", POLITISCHE VIERTELJAHRESSCHRIFT,1992, Vol 33, Iss 3, pp 489-509

Hoke-F, "Science in the Courtroom - What Evidence Is Admissible - And Who Decides - Some Scientists Say a Supreme-Court Decision to Deemphasize Peer-Review Has Led to Better Court Science .1.", SCIENTIST,1994, Vol 8, Iss 12, pp 1+

Holdsworth-N Guy-W, "Problems of Service Assessment Abintra - Research and Evaluation Relating to a New Early Intervention Community Psychiatric Nursing Service", JOURNAL OF ADVANCED NURSING,1994, Vol 19, Iss 2, pp 290-298

Hollander-MJ Prince-MJ, "Analytical Units in Federal and Provincial Governments - Origins, Functions and Suggestions for Effectiveness", CANADIAN PUBLIC ADMINISTRATION-ADMINISTRATION PUBLIQUE DU CANADA,1993, Vol 36, Iss 2, pp 190-224

Hollis-DR, "Measuring Worldwide Connectivity - Expansion of the Internet", JOURNAL OF GOVERNMENT INFORMATION 1996, Vol 23, Iss 4, pp 499-513

Hollman-KW Murrey-JH Homaifar-G, "The Structure and Disciplinary Boundaries of Insurance - A Citational Analysis of Jri Articles", JOURNAL OF RISK AND INSURANCE,1991, Vol 58, Iss 4, pp 714-721

Holmes-DS, "Rapid Preparation of Plasmids - A Citation-Classic Commentary on a Rapid Method for the Preparation of Plasmids by Holmes,D.S., Quigley,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 42, pp 9-9

Holzemer-WL, "The Impact of Nursing-Care in Latin-America and the Caribbean - A Focus on Outcomes", JOURNAL OF ADVANCED NURSING,1994, Vol 20, Iss 1, pp 5-12

Hopkins-L, "Practical Performance Indicators - ,1992 - Documenting the Citizens Charter Consultation for UK Public-Libraries with Examples of Pls and Survey in Use, by J.W. Sumsion", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1995, Vol 27, Iss 1, pp 57-58

Hopper-KD Rosetti-GF Edmiston-RB Madewell-JE Beam-LM Landis-JR Miller-KL Ricci-JA Mccauslin-MA, "Diagnostic-Radiology Peer-Review - A Method Inclusive of All Interpreters of Radiographic Examinations Regardless of Specialty", RADIOLOGY,1991, Vol 180, Iss 2, pp 557-561

Horton-R, "Peer-Review ,1993", LANCET,1993, Vol 342, Iss 8873, pp 735-735

Hoskins-DD, "Developments and Trends in Social-Security, 1990-,1992 - Overview of Principal Trends", SOCIAL SECURITY BULLETIN,1992, Vol 55, Iss 4, pp 36-42

Houdek-FG, "The Final Report of the Task-Force on Citation Formats - Editors Introductory Note", LAW LIBRARY JOURNAL 1995, Vol 87, Iss 3, pp 577-579

Houlihan-D Hofschulte-L Sachau-D Patten-C, "Critiquing the Peer-Review Process - Examining a Potential Dual Role-Conflict", AMERICAN PSYCHOLOGIST,1992, Vol 47, Iss 12, pp 1679-1681

Houmard-J, "A Very Welcome Protease - A Citation-Classic Commentary on Staphylococcal Protease - A Proteolytic-Enzyme Specific for Glutamoyl Bonds by Houmard,J. and Drapeau,G.R.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 34, pp 11-11

Houston-DJ, "Search for Identity - The Impact of the Great Books in Public-Administration", INTERNATIONAL JOURNAL OF PUBLIC ADMINISTRATION,1993, Vol 16, Iss 5, pp 747-780

Howard-GS, "Why Would Someone Make Questionable Methodological Judgments", COUNSELING PSYCHOLOGIST,1994, Vol 22, Iss 1, pp 165-170

Howard-GS Curtin-TD, "Individual Productivity and Impact in Counseling Psychology", COUNSELING PSYCHOLOGIST,1993, Vol 21, Iss 2, pp 288-302

Howard-MO Howard-DA, "Citation Analysis of 541 Articles Published in Drug and Alcohol Journals - 1984-1988", JOURNAL OF STUDIES ON ALCOHOL,1992, Vol 53, Iss 5, pp 427-434

Howell-SE Sims-RT, "Abortion Attitudes and the Louisiana Governors Election", AMERICAN POLITICS QUARTERLY,1993, Vol 21, Iss 1, pp 54-64

Howie-JGR Stott-NCH, "The Universities Research Assessment Exercise ,1992 - A 2nd Opinion", LANCET,1993, Vol 342, Iss 8872, pp 665-666

Howitt-PS Moore-EA, "Pay Now So You Wont Pay Later - The Effectiveness of Prevention Programming in the Fight to Reduce Delinquency", JUVENILE & FAMILY COURT JOURNAL,1993, Vol 44, Iss 2, pp 57-67

Hrdy-SB, "Infanticide As a Reproductive Strategy - A Citation-Classic Commentary on Infanticide Among Animals - A Review, Classification, and Examination of the Implications for the Reproductive Strategies of Females by Hrdy,S.B.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 40, pp 8-8

Hsu-SM, "Avidin-Biotin Detection Methods - A Citation-Classic Commentary on Use of Avidin-Biotin-Peroxidase Complex (ABC) in Immunoperoxidase Techniques - A Comparison Between ABC and Unlabeled Antibody (PAP) Procedures by Hsu,S.M., Raine,L., and Fanger,H.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 18, pp 9-9

Huang-SY Sexton-RJ, "Measuring Returns to an Innovation in an Imperfectly Competitive Market - Application to Mechanical Harvesting of Processing Tomatoes in Taiwan", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 1996, Vol 78, Iss 3, pp 558-571

Hubbell-JH, "Faster Than a Speeding Photon - A Citation-Classic Commentary on Visible-Light from Clear Liquids Under the Action of Gamma-Radiation by Cherenkov,P.A.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 34, pp 10-10

Hudson-H, "Universal Service in the Information Age", TELECOMMUNICATIONS POLICY,1994, Vol 18, Iss 8, pp 658-667

Hudson-T, "Austin Decision Good-News for Peer Reviewers", HOSPITALS,1993, Vol 67, Iss 2, pp 46-&

Hudson-T, "Hospitals Work Through Superfund Citations", HOSPITALS,1993, Vol 67, Iss 1, pp 14-16

Huffaker-CB, "Continuity in Natural Environments - A Citation-Classic Commentary on Experimental Studies on Predation - Dispersion Factors and Predator-Prey Oscillations by Huffaker,C.B.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 2, pp 8-8

Huffman-WE Just-RE, "Funding, Structure, and Management of Public Agricultural-Research in the United-States", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1994, Vol 76, Iss 4, pp 744-759

Hughes-J, "Bibliomed Citation Series", CD-ROM PROFESSIONAL,1994, Vol 7, Iss 3, pp 150-151

Hull-GH Johnson-HW, "Publication Rates of Undergraduate Social-Work Programs in Selected Journals", JOURNAL OF SOCIAL WORK EDUCATION,1994, Vol 30, Iss 1, pp 54-62

Hummon-NP Carley-K, "Social Networks as Normal Science", SOCIAL NETWORKS,1993, Vol 15, Iss 1, pp 71-106

Hunt-C Andrews-G, "Drop-Out Rate as a Performance Indicator in Psychotherapy", ACTA PSYCHIATRICA SCANDINAVICA,1992, Vol 85, Iss 4, pp 275-278

Hunt-JGJ, "Citation-Classics - Introduction", LEADERSHIP QUARTERLY 1996, Vol 7, Iss 3, pp 303-304

Hunter-GS, "Research and Evaluation for Information Professionals, by R.M. Losee, K.A. Worley", AMERICAN ARCHIVIST 1995, Vol 58, Iss 2, pp 217-218

Hunter-J Higginson-I Garralda-E, "Systematic Literature-Review - Outcome Measures for Child and Adolescent Mental-Health-Services", JOURNAL OF PUBLIC HEALTH MEDICINE 1996, Vol 18, Iss 2, pp 197-206

Hunter-WW Stewart-JR Stutts-JC Marchetti-LM, "Nonsanction Seat-Belt Law-Enforcement - A Modern-Day Tale of 2 Cities", ACCIDENT ANALYSIS AND PREVENTION,1993, Vol 25, Iss 5, pp 511-520

Huot-C Quoniam-L Dou-H, "A New Method for Analyzing Downloaded Data for Strategic Decision", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 279-294

Hurlbert-SH, "Dragging Statistical Malpractice into the Sunshine - A Citation-Classic Commentary on Pseudoreplication and the Design of Ecological Field Experiments by Hurlbert,S.H.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 12, pp 8-8

Hurt-CD Budd-JM, "Modeling the Literature of Superstring Theory - A Case of Fast Literature", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 471-480

Husman-K, "Principles and Pitfalls in Health-Services Research in Occupational-Health Systems", OCCUPATIONAL MEDICINE-OXFORD,1993, Vol 43, Iss S1, pp S10-S14

Hussain-SSM Nunez-DA, "British Otorhinolaryngological Research - An Analysis of Publication Trends", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 255-262

Huston-P, "Developments in Peer-Review", CANADIAN MEDICAL ASSOCIATION JOURNAL,1993, Vol 149, Iss 8, pp 1063-1063

Huston-P, "Information for Peer Reviewers", CANADIAN MEDICAL ASSOCIATION JOURNAL,1994, Vol 150, Iss 8, pp 1211-1216

Huston-P, "Peer-Review", CANADIAN MEDICAL ASSOCIATION JOURNAL 1996, Vol 154, Iss 4, pp 439-439

Huston-P, "Reporting on Surveys - Information for Authors and Peer Reviewers", CANADIAN MEDICAL ASSOCIATION JOURNAL 1996, Vol 154, Iss 11, pp 1695-1698

Huston-P Elmslie-T, "Program Descriptions - Information for Authors and Peer Reviewers", CANADIAN MEDICAL ASSOCIATION JOURNAL 1996, Vol 155, Iss 8, pp 1069-1071

Huston-P Squires-BP, "Case-Reports - Information for Authors and Peer Reviewers", CANADIAN MEDICAL ASSOCIATION JOURNAL 1996, Vol 154, Iss 1, pp 43-44

Hutchinson-EB Zivney-TL, "The Publication Profile of Economists", JOURNAL OF ECONOMIC EDUCATION,1995, Vol 26, Iss 1, pp 59-79

Hutchison-CA, "The Triplet Nature of the Phosphorescent State - A Citation-Classic Commentary on Paramagnetic-Resonance Absorption in Naphthalene in Its Phosphorescent State by Hutchison,C.A. and Mangum,B.W.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 26, pp 9-9

Huygen-FJA Mokkink-HGA Smits-AJA Vanson-JAJ Meyboom-WA Vaneyk-JTM, "Relationship Between the Working Styles of General-Practitioners and the Health-Status of Their Patients",

BRITISH JOURNAL OF GENERAL PRACTICE,1992, Vol 42, Iss 357, pp 141-144
Ianniello-L, "Doe Peer-Review", SCIENCE,1994, Vol 265, Iss 5170, pp 302-302
Iezzoni-LI Daley-J Heeren-T Foley-SM Hughes-JS Fisher-ES Duncan-CC Coffman-GA, "Using Administrative Data to Screen Hospitals for High Complication Rates", INQUIRY-THE JOURNAL OF HEALTH CARE ORGANIZATION PROVISION AND FINANCING,1994, Vol 31, Iss 1, pp 40-55
Imperato-PJ, "Demise of a Peer-Reviewed Journal", LANCET,1993, Vol 342, Iss 8880, pp 1160-1161
Ingle-KG, "Typology Research Questionnaires", ALCOHOL HEALTH & RESEARCH WORLD 1996, Vol 20, Iss 1, pp 63-66
Ingwersen-P, "Cognitive Perspectives of Information-Retrieval Interaction - Elements of a Cognitive Ir Theory", JOURNAL OF DOCUMENTATION 1996, Vol 52, Iss 1, pp 3-50
Irizar-KS Mas-MB Gallo-CB Odriozola-EE, "Treatment of Social Phobia - A Bibliometric Analysis (1974-1994)", PSICOLOGIA CONDUCTUAL 1996, Vol 4, Iss 1, pp 111-121
Isom-P Johnson-E Mccollum-J Zillmann-D, "Perception of Interviewees with Less-Than-Perfect English - Implications for Newspaper Citations", JOURNALISM & MASS COMMUNICATION QUARTERLY 1995, Vol 72, Iss 4, pp 874-882
Ivahnenko-GA, "Comparative Analyses of the Citations in Socis and Scientifical Communism", SOTSIOLOGICHESKIE ISSLEDOVANIYA,1994, Iss 2, pp 118-122
Ivanov-SA, "Theoretical Basis of Lotkas Empiric Law on Frequency-Distribution of Scientific Performance", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 2-INFORMATSIONNYE PROTSESSY I SISTEMY,1991, Iss 11, pp 6-13
Iwarsson-S Isacsson-A, "Development of a Novel Instrument for Occupational-
Therapy of Assessment of the Physical-Environment in the Home - A Methodologic Study on the Enabler", OCCUPATIONAL THERAPY JOURNAL OF RESEARCH 1996, Vol 16, Iss 4, pp 227-244
Iwata-BA, "Functional-Analysis Methodology - Some Closing Comments", JOURNAL OF APPLIED BEHAVIOR ANALYSIS,1994, Vol 27, Iss 2, pp 413-418
Izatt-RM, "Thermodynamic and Kinetic Data Can Be Useful - A Citation-Classic Commentary on Thermodynamic and Kinetic Data for Cation-Macrocycle Interaction by Izatt,R.M., Bradshaw,J.S., Nielson,S.A., Lamb,J.D., Christensen,J.J., and Sen,D.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 10, pp 8-8
J-SOC-WORK, "Social-Work Research and Evaluation, 4th Edition, by R.M. Grinnell", JOURNAL OF SOCIAL WORK EDUCATION,1993, Vol 29, Iss 1, pp 130-130
J-TAXATION, "Disclosure Allowed for Peer-Review, Illness, or Death", JOURNAL OF TAXATION,1991, Vol 74, Iss 3, pp 164
Jaccard-J, "Adolescent Contraceptive Behavior - The Impact of the Provider and the Structure of Clinic-Based Programs", OBSTETRICS AND GYNECOLOGY 1996, Vol 88, Iss 3, pp S57-S64
Jachna-JS Powsner-SM Miller-PL, "Augmenting Grateful Med with the Umls Metathesaurus - An Initial Evaluation", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol 81, Iss 1, pp 20-28

Jackson-AP, "Black, Single, Working Mothers in Poverty - Preferences for Employment, Well-Being, and Perceptions of Preschool-Age Children", SOCIAL WORK,1993, Vol 38, Iss 1, pp 26-34

Jackson-GJ Wachsmuth-IK, "The Us Food and Drug Administrations Selection and Validation of Tests for Foodborne Microbes and Microbial Toxins", FOOD CONTROL 1996, Vol 7, Iss 1, pp 37-39

Jackson-MS Schmierer-CL Schneider-Z, "Development, Refinement and Future Usage of the Scale - Attitudes Toward Learning in Pregnancy", INTERNATIONAL JOURNAL OF NURSING STUDIES 1996, Vol 33, Iss 1, pp 37-46

Jacobowitz-DM Palkovits-M, "The Birth of Neurochemical Maps - A Citation-Classic Commentary on Topographic Atlas of Catecholamine and Acetylcholinesterase-Containing Neurons in the Rat-Brain .1. Forebrain (Telencephalon, Diencephalon) .2. Hindbrain (Mesencephalon, Rhombencephalon) by Jacobowitz,D.M., and Palkovits,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 34, pp 9-9

Jacobs-A Worwood-M, "Serum Ferritin, or Being in the Right Place at the Right Time - A Citation-Classic Commentary on Ferritin in the Serum of Normal Subjects and Patients with Iron-Deficiency and Iron Overload by Jacobs,A., Miller,F., Worwood,M., Beamish,M.R., and Wardrup,C.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 4, pp 8-8

Jacobson-L, "Citation Analyses - Further Implications", SOUTH AFRICAN JOURNAL OF SCIENCE,1992, Vol 88, Iss 5, pp 249-249

Jacono-BJ Jacono-JJ, "The Potential Negative Impact of Current Orthodoxy on Nursing-Education", NURSE EDUCATION TODAY,1994, Vol 14, Iss 3, pp 245-248

Jaffe-AB Trajtenberg-M Henderson-R, "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations", QUARTERLY JOURNAL OF ECONOMICS,1993, Vol 108, Iss 3, pp 577-598

Jaffe-AB Trajtenberg-M, "Flows of Knowledge from Universities and Federal Laboratories - Modeling the Flow of Patent Citations over Time and Across Institutional and Geographic Boundaries", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 1996, Vol 93, Iss 23, pp 12671-12677

Jagodzinskisigogneau-M Bauin-S Courtial-JP Feillet-H, "Scientific Innovation in Bibliographical Databases - A Comparative-Study of the Science-Citation-Index and the Pascal Database", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 65-82

Jain-A Garg-KC, "Laser Research in India - Scientometric Study and Model Projections", SCIENTOMETRICS,1992, Vol 23, Iss 3, pp 395-415

Jalbert-PL, "Critique and Analysis in Media Studies - Media Criticism as Practical Action", DISCOURSE & SOCIETY,1995, Vol 6, Iss 1, pp 7-26

Janes-J, "Research and Evaluation for Information Professionals, by R.M. Losee, K.A. Worley", JOURNAL OF ACADEMIC LIBRARIANSHIP,1993, Vol 19, Iss 5, pp 313-314

Janick-J, "Citations and Careers", SCIENCE,1991, Vol 252, Iss 5014, pp 1769-1769

Jankowski-RF, "Performance Indicators in General-Practice", BRITISH MEDICAL JOURNAL,1993, Vol 307, Iss 6915, pp 1356-1356

Janssen-PAJ Niemegeers-CJE, "New Assay for the Most Popular

Narcotic Analgesic - A Citation-Classic Commentary on the Inhibitory Effect of Fentanyl and Other Morphine-Like Analgesics on the Warm Water Induced Tail Withdrawal Reflex in Rats by Janssen,P.A.J., Niemegeers,C.J.E. and Dony,J.G.H.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 34, pp 10-10

Jardetzky-O, "Quality Judgments, Cost Concerns Must Be Separated in Peer-Review", SCIENTIST 1996, Vol 10, Iss 14, pp 10-10

Jarett-L, "From Embedding to Insulin Action - A Citation-Classic Commentary on Embedding in Epoxy-Resins for Ultrathin Sectioning in Electron-Microscopy by Richardson,K.C., Jarett,L. and Finke,E.H.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 36, pp 8-8

Jaschek-C, "The Size of the Astronomical Community", SCIENTOMETRICS,1991, Vol 22, Iss 2, pp 265-282

Jaschek-C, "The Visibility of West European Astronomical Research", SCIENTOMETRICS,1992, Vol 23, Iss 3, pp 377-393

JBMR, "Asbmr Award Citations - Albright, Bartter and Neuman Awards", JOURNAL OF BONE AND MINERAL RESEARCH 1996, Vol 11, Iss 2, pp 145-149

JCSD, "Indicators in Higher-Education, by G. Gaither, B.P. Nedwek, J.E. Neal", JOURNAL OF COLLEGE STUDENT DEVELOPMENT 1996, Vol 37, Iss 4, pp 475-477

Jeannin-P Devillard-J, "Towards a Demographic Approach to Scientific Journals", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 83-95

Jefferson-T Shapland-J, "Criminal-Justice and the Production of Order and Control - Criminological Research in the UK in the 1980s", BRITISH JOURNAL OF CRIMINOLOGY, 1994, Vol 34, Iss 3, pp 265-290

Jenkins-JJ Strange-W Miranda-S, "Vowel Identification in Mixed-Speaker Silent-Center Syllables", JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA,1994, Vol 95, Iss 2, pp 1030-1043

Jenne-JW, "Pharmacokinetics and Drug-Monitoring - A Citation-Classic Commentary on Pharmacokinetics of Theophylline - Application to Adjustment of Clinical Dose of Aminophylline by Jenne,J.W., Wyse,E., Rood,F.S. and Mcdonald,F.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 6, pp 10-10

Jensen-MC Long-JB Ruback-RS Schwert-GW Smith-CW Warner-JB Fama-EF, "Citation Index Ratings of the Journal of Financial Economics", JOURNAL OF FINANCIAL ECONOMICS1990, Vol 28, Iss 1-2, pp 3-5

Jerger-S, "In Honor of Peer Reviewers", EAR AND HEARING,1993, Vol 14, Iss 6, pp 375-377

Jex-SM Spector-PE, "The Impact of Negative Affectivity on Stressor Strain Relations - A Replication and Extension", WORK AND STRESS 1996, Vol 10, Iss 1, pp 36-45

Jimenezcontreras-E Ferreiroalaez-L, "Publishing Abroad - Fair Trade or Short Sell for Non-English-Speaking Authors - A Spanish Study", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 81-95

Johnes-G, "Performance Indicators in Higher-Education - A Survey of Recent Work", OXFORD REVIEW OF ECONOMIC POLICY,1992, Vol 8, Iss 2, pp 19-34

Johnes-G, "Research Performance-Measurement - What Can International Comparisons Teach Us", COMPARATIVE EDUCATION,1994, Vol 30, Iss 3, pp 205-216

Johnes-G Johnes-J, "Apples and Oranges - The Aggregation Problem in Publications Analysis", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 353-365

Johnes-G Johnes-J, "Measuring the Research Performance of UK Economics Departments - An Application of Data Envelopment Analysis", OXFORD ECONOMIC PAPERS-NEW SERIES,1993, Vol 45, Iss 2, pp 332-347

Johnes-J, "Performance Assessment in Higher-Education in Britain", EUROPEAN JOURNAL OF OPERATIONAL RESEARCH 1996, Vol 89, Iss 1, pp 18-33

Johnes-J, "The Use of Performance Indicators in Higher-Education - A Critical Analysis of Developing Practice, 2nd Edition, by M. Cave, S. Hanney, M. Kogan", STUDIES IN HIGHER EDUCATION,1992, Vol 17, Iss 2, pp 243-244

Johnes-J Taylor-J Francis-B, "The Research Performance of UK Universities - A Statistical-Analysis of the Results of the 1989 Research Selectivity Exercise", JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES A-STATISTICS IN SOCIETY,1993, Vol 156, Iss P2, pp 271-286

Johnsen-SK Ryser-GR, "An Overview of Effective Practices with Gifted Students in General-Education Settings", JOURNAL FOR THE EDUCATION OF THE GIFTED 1996, Vol 19, Iss 4, pp 379-404

Johnson-D, "Measurement to Improve Scientific Productivity - A Reflection on the Brown Report", PSYCHOLOGICAL SCIENCE,1993, Vol 4, Iss 2, pp 67-69

Johnson-D, "Psychology in Washington - Can Fixing Peer-Review Fix American Science", PSYCHOLOGICAL SCIENCE,1991, Vol 2, Iss 4, pp 211-212

Johnson-DAW, "Cognitive Therapy and Recovery from Acute-Psychosis - Peer-Review", BRITISH JOURNAL OF PSYCHIATRY 1996, Vol 169, Iss 5, pp 608-609

Johnson-DM, "Compliments and Politeness in Peer-Review Texts", APPLIED LINGUISTICS,1992, Vol 13, Iss 1, pp 51-71

Johnson-DM Roen-DH, "Complimenting and Involvement in Peer Reviews - Gender Variation", LANGUAGE IN SOCIETY,1992, Vol 21, Iss 1, pp 27-57

Johnston-R, "Effects of Resource Concentration on Research Performance", HIGHER EDUCATION,1994, Vol 28, Iss 1, pp 25-37

Johnston-R, "Research Impact Quantification", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 415-426

Johnston-RJ, "Removing the Blindfold After the Game Is over - The Financial Outcomes of the ,1992 Research Assessment Exercise", JOURNAL OF GEOGRAPHY IN HIGHER EDUCATION,1993, Vol 17, Iss 2, pp 174-180

Johnston-RJ, "Research Performance Indicators for Geography", AREA 1995, Vol 27, Iss 2, pp 127-136

Johnston-RJ, "The Quality Industry in British Higher-Education and the Aags Publications", PROFESSIONAL GEOGRAPHER,1994, Vol 46, Iss 4, pp 491-497

Johnston-WJ Lewin-JE, "Organizational Buying Behavior - Toward an Integrative Framework", JOURNAL OF BUSINESS RESEARCH 1996, Vol 35, Iss 1, pp 1-15

Jolobe-OMP, "The Dissemination of False Data Through Inadequate

Citation", JOURNAL OF INTERNAL MEDICINE 1996, Vol 239, Iss 5, pp 461-461

Joly-PB Mangematin-V, "Profile of Public Laboratories, Industrial Partnerships and Organizations of Research-and-Development - The Dynamics of Industrial Relationships in a Large Research Organization", RESEARCH POLICY 1996, Vol 25, Iss 6, pp 901-922

Jones-AW, "The Impact of Forensic-Science Journals", FORENSIC SCIENCE INTERNATIONAL,1993, Vol 62, Iss 3, pp 173-178

Jones-JE Preusz-GC, "Attitudinal Factors Associated with Individual Faculty Research Productivity in Academic Dentistry", PERCEPTUAL AND MOTOR SKILLS,1993, Vol 76, Iss 3, pp 1191-1198

Jones-MJ Brinn-T Pendlebury-M, "Journal Evaluation Methodologies - A Balanced Response", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 5, pp 607-612

Jones-MJ Brinn-T Pendlebury-M, "Judging the Quality of Research in Business Schools - A Comment from Accounting", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 5, pp 597-602

Jonscher-A, "Towards the Significance of Disorder - 2 Citation-Classic Commentary on Electronic-Properties of Amorphous Dielectric Films by Jonscher,A.K.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 16, pp 8-8

Joswick-KE, "A Comparison of OCLC and Illinet Online as Tools for Pre-Order Citation Verification", LIBRARY ACQUISITIONS-PRACTICE AND THEORY,1992, Vol 16, Iss 1, pp 31-41

JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE, Keys to Success, by Performance, Indicators, For, Public-Libraries", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1992, Vol 24, Iss 2, pp 111-111

Jouvet-M, "From Amines to Sleep - A Citation-Classic Commentary on the Role of Monoamines and Acetylcholine-Containing Neurons in the Regulation of the Sleep-Waking Cycle by Jouvet,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 12, pp 8-8

Jouvet-M, "From Amines to Sleep - A Citation-Classic Commentary on the Role of Monoamines and Acetylcholine-Containing Neurons in the Regulation of Sleep-Waking Cycle by Jouvet,M.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 4, pp 8-8

Judd-LR, "Importance and Use of Formal Research and Evaluation", PUBLIC RELATIONS REVIEW1990, Vol 16, Iss 4, pp 17-28

Judge-TA Ferris-GR, "Social-Context of Performance Evaluation Decisions", ACADEMY OF MANAGEMENT JOURNAL,1993, Vol 36, Iss 1, pp 80-105

Judson-HF, "Structural Transformations of the Sciences and the End of Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 92-94

Julien-H, "A Content-Analysis of the Recent Information Needs and Uses Literature", LIBRARY & INFORMATION SCIENCE RESEARCH 1996, Vol 18, Iss 1, pp 53-65

Jungnickel-PW Creswell-JW, "Workplace Correlates and Scholarly Performance of Clinical Pharmacy Faculty", RESEARCH IN HIGHER EDUCATION,1994, Vol 35, Iss 2, pp 167-194

Justice-AC Berlin-JA Fletcher-SW Fletcher-RH Goodman-SN,

"Do Readers and Peer Reviewers Agree on Manuscript Quality", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 117-119

Justiss-LK, "A Bibliometric Study of Texas Law Reviews", LAW LIBRARY JOURNAL,1993, Vol 85, Iss 2, pp 407-408

Juzych-MS Shin-DH Coffey-JB Parrow-KA Tsai-CS Briggs-KS, "Pattern of Publication of Ophthalmic Abstracts in Peer-Reviewed Journals", OPHTHALMOLOGY,1991, Vol 98, Iss 4, pp 553-556

Kaariainen-L, "A New Disease for an Old Virus - A Citation-Classic Commentary on Cytomegalovirus As a Possible Cause of a Disease Resembling Infectious-Mononucleosis by Klemola,E., and Kaariainen,L. and Rise of Cytomegalovirus Antibodies in an Infectious-Mononucleosis-Like Syndrome After Transfusion by Kaariainen,L., Klemola,E., and Paloheimo,J.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 34, pp 10-10

Kaback-SM Lambert-N Simmons-ES, "Patent Citation Data - Source of Insights, or Nothing to Get Excited About", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 44-CINF

Kabanova-OL Bakanova-LV Markova-IV Shirokova-VI, "A Scientometric Study on Publications on Electrochemical Analysis-Methods for Inorganic Substances 1974-1989", JOURNAL OF ANALYTICAL CHEMISTRY OF THE USSR,1991, Vol 46, Iss 5, pp 729-739

Kahn-CR, "Identification of the Insulin-Receptor Tyrosine Kinase-Activity - A Citation-Classic Commentary on Insulin Stimulates the Phosphorylation of the 95,000 Dalton Subunit of Its Own Receptor by Kasuga,M., Karlsson,F.A., Kahn,C.R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 46, pp 9-9

Kahn-CR, "Identification of the Insulin-Receptor Tyrosine Kinase-Activity - A Citation-Classic Commentary on Insulin Stimulates the Phosphorylation of the 95,000 Dalton Subunit of Its Own Receptor by Kasuga,M., Karlsson,F.A., Kahn,C.R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 46, pp 9-9

Kajberg-L, "A Citation Analysis of LIS Serial Literature Published in Denmark 1957-1986", JOURNAL OF DOCUMENTATION 1996, Vol 52, Iss 1, pp 69-85

Kajberg-L, "A Content-Analysis of Library and Information-Science Serial Literature Published in Denmark, 1957-1986", LIBRARY & INFORMATION SCIENCE RESEARCH 1996, Vol 18, Iss 1, pp 25-52

Kajioka-R Desavigny-D, "The Cultivation of Human Hematopoietic-Cells from Peripheral-Blood - A Citation-Classic Commentary on Cultivation in-Vitro of Myeloblasts from Human Leukemia by Iwakata,S. and Grace,J.T.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 30, pp 9-9

Kalra-L Jackson-SHD Swift-CG, "Neuropsychological Test-Performance as an Indicator of Silent Cerebrovascular-Disease in Elderly Hypertensives", AGE AND AGEING,1994, Vol 23, Iss 6, pp 517-523

Kameoka-A, "Evaluating Research Projects at Toshiba - Designing a Conceptual-Framework of Evaluating Research and Technology Development (Rtd) Programs", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 427-439

Kando-N Nozue-M Harita-T Murakami-T Yatsu-M Ueda-S, "Structure of Information-Retrieval Research - Tracking the Specialties and Development of Research Using Cocitation Maps and Citation Diagrams", LIBRARY AND INFORMATION SCIENCE,1991, Iss 29, pp 39-65

Kantha-SS, "Scientific Productivity of Einstein, Freud and Landsteiner", MEDICAL HYPOTHESES 1996, Vol 46, Iss 5, pp 467-470

Karas-GA Lazarev-VS, "Use of Bibliometric Techniques for Operative Assessment of Scientific Activity of Research Medicobiological Institutes", VESTNIK AKADEMII MEDITSINSKIKH NAUK SSSR,1991, Iss 4, pp 61-65

Karki-R, "Searching for Bridges Between Disciplines - An Author Cocitation Analysis on the Research into Scholarly Communication", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 5, pp 323-334

Karmyjones-R Copes-WS Champion-HR Weigelt-J Shackford-S Lawnick-M Rozycki-GS Hollingsworthfridlund-P Klein-J, "Results of a Multiinstitutional Outcome Assessment - Results of a Structured Peer-Review of Triss-Designated Unexpected Outcomes", JOURNAL OF TRAUMA,1992, Vol 32, Iss 2, pp 196-203

Karnovsky-MJ, "Lead Staining Without Dross - A Citation-Classic Commentary on Simple Methods for Staining with Lead at High pH in Electron-Microscopy by Karnovsky,M.J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 22, pp 11-11

Kaspar-P, "Study-Group to Peer-Review Group - A Case of Natural Evolution", BRITISH DENTAL JOURNAL,1993, Vol 174, Iss 8, pp 299-299

Kassirer-JP Campion-EW, "Peer-Review - Crude and Understudied, But Indispensable", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 96-97

Kato-R, "Diet, Drugs, and Poisons - A Citation-Classic Commentary on Toxicity and Metabolism of Drugs in Relation to Dietary-Protein by Kato,R., Oshima,T. and Tomizawa,S.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 14, pp 11-11

Katovich-MA Kinkade-PT, "The Stories Told in Science-Fiction and Social-Science - Reading the Thing and Other Remakes from 2 Eras", SOCIOLOGICAL QUARTERLY,1993, Vol 34, Iss 4, pp 619-651

Katz-J, "Peer-Review Study", SCIENCE,1994, Vol 266, Iss 5187, pp 955-955

Katz-JS, "Bibliometric Standards - Personal-Experience and Lessons Learned", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 193-197

Katz-JS, "Geographical Proximity and Scientific Collaboration", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 31-43

Katz-JS Hicks-DM, "A Systemic View of British Science", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 133-154

Katz-JS Hicks-D Narin-F Hamilton-K, "International Collaboration", NATURE 1996, Vol 381, Iss 6577, pp 16-16

Kauzmann-W, "The Kauzmann Paradox - A Thermodynamic Quandary - A Citation-Classic Commentary on the Nature of the Glassy State and the Behavior of Liquids at Low-Temperatures byKauzmann,W.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 44, pp 8-8

Kawano-T Kehle-TJ Clark-E Jenson-WR, "School-Psychology Journals - Relationships with Related Journals and External and Internal Quality Indexes", JOURNAL OF SCHOOL PSYCHOLOGY,1993, Vol 31,

Iss 3, pp 407-424

Kawula-JD, "Similarities Between Legal and Scientific Literature", SPECIAL LIBRARIES,1993, Vol 84, Iss 2, pp 85-89

Kay-DWK Roth-M, "Mental-Disorders in an Elderly Urban-Population - A Citation-Classic Commentary on Old-Age Mental-Disorders in Newcastle-upon-Tyne .1. A Study of Prevalence by Kay,D.W.K., Beamish,P., and Roth,M.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 26, pp 8-8

Kazandjian-VA Thomson-RG Law-WR Waldron-K, "Do Performance Indicators Make a Difference", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT 1996, Vol 22, Iss 7, pp 482-491

Kazdin-AE, "Preparing and Evaluating Research Reports", PSYCHOLOGICAL ASSESSMENT 1995, Vol 7, Iss 3, pp 228-237

Keady-J, "The Experience of Dementia - A Review of the Literature and Implications for Nursing Practice", JOURNAL OF CLINICAL NURSING 1996, Vol 5, Iss 5, pp 275-288

Kealey-T, "Government-Funded Academic Science Is a Consumer Good, Not a Producer Good - A Comparative Reassessment of Britain Scientific and Technological Achievements Since 1794 and a Comment on the Bibliometry of Martin,B. and Irvine,J.", SCIENTOMETRICS,1991, Vol 20, Iss 2, pp 369-394

Keay-CSL, "Physics, Psychology and Respectability", SCIENTOMETRICS,1992, Vol 23, Iss 3, pp 355-359

Kebabian-JW, "Multiple Receptors for Dopamine - A Citation-Classic Commentary on Multiple Receptors for Dopamine by Kebabian,J.W. and Calne,D.B.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 4, pp 8-8

Kebarle-P, "A New Phase for Ionic Reactions - A Citation-Classic Commentary on Ion Thermochemistry and Solvation from Gas-Phase Ion Equilibria by Kebarle,P.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 6, pp 10-10

Keefe-FJ Hauck-ER Egert-J Rimer-B Kornguth-P, "Mammography Pain and Discomfort - A Cognitive-Behavioral Perspective", PAIN,1994, Vol 56, Iss 3, pp 247-260

Keenan-TW Morre-DJ, "Golgi-Apparatus Lipids - A Citation-Classic Commentary on Phospholipid Class and Fatty-Acid Composition of Golgi-Apparatus Isolated from Rat-Liver and Comparison with Other Cell Factions by Keenan,T.W., and Morre,D.J. and Ganglioside Biosynthesis - Concentration of Glycosphingolipid Glycosyltransferases in Golgi-Apparatus from Rat-Liver by Kennan,T.W., Morre,D.J. and Basu,S.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 32, pp 9-9

Kefalides-NA, "Finding New Collagen in the Basement (Membrane) - A Citation-Classic Commentary on Structure and Biosynthesis of Basement-Membranes, by Kefalides,N.A.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 30, pp 11-11

Kefalides-NA, "Type-IV Collagen - From the Basement to the Penthouse - A Citation-Classic Commentary on Biochemistry and Metabolism of Basement-Membranes by Kefalides,N.A., Alper,R., Clark,C.C.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 32, pp 8-8

Keitel-W, "Quality Assurance in Rheumatology", ZEITSCHRIFT FUR RHEUMATOLOGIE 1996, Vol 55, Iss 3, pp 143-148

Kellie-SE Kelly-JT, "Medicare Peer-Review Organization Preprocedure Review Criteria - An Analysis of Criteria for 3 Procedures", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1991, Vol 265, Iss 10, pp 1265-1270

Kelly-M Maynardmoody-S, "Policy Analysis in the Post-Positivist Era - Engaging Stakeholders in Evaluating the Economic-Development Districts Program", PUBLIC ADMINISTRATION REVIEW,1993, Vol 53, Iss 2, pp 135-142

Kelt-DA Palma-RE, "A Plea for Adequate Citation of Authors of Taxa in Systematic Studies", PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON,1992, Vol 105, Iss 3, pp 411-413

Kemper-KJ, "Pride and Prejudice in Peer-Review", JOURNAL OF CLINICAL EPIDEMIOLOGY,1991, Vol 44, Iss 4-5, pp 343-345

Kendrick-A, "A Comparison of Publication Output for Academic Business Librarians with and Without Faculty Rank", JOURNAL OF ACADEMIC LIBRARIANSHIP,1991, Vol 17, Iss 3, pp 145-147

Keng-A Coley-RMR, "Evaluating the Accuracy of Citations in Drug Promotional Brochures", ANNALS OF PHARMACOTHERAPY,1994, Vol 28, Iss 11, pp 1231-1235

Keown-D, "The Journal of Buddhist Ethics - An Online Journal", LEARNED PUBLISHING 1996, Vol 9, Iss 3, pp 141-145

Kernan-JB, "Framing a Rainbow, Focusing the Light - Jcrs First 20 Years", ADVANCES IN CONSUMER RESEARCH 1995, Vol 22, pp 488-496

Kessler-H, "Molecular Mobility by NMR - A Citation-Classic Commentary on Detection of Hindered Rotation and Inversion by NMR-Spectroscopy by Kessler,H.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 38, pp 10-10

Kessler-HB Clair-MR, "Development and Implementation of a Peer-Review Quality Assurance Program for Obstetric Us - Financial Analysis and Results", RADIOLOGY,1992, Vol 185, Iss S, pp 143-143

Ketko-EG Suptelo-LP, "An Analysis of Modern Trends in the Development of Ecological Oncology (Scientometrics of Information Flows)", EKSPERIMENTALNAYA ONKOLOGIYA,1993, Vol 15, Iss 3, pp 74-79

Khan-MA Wortham-JW Watzman-N Green-JG, "The National-Institutes-of-Health Is Going High-Tech in Peer-Review", FASEB JOURNAL,1992, Vol 6, Iss 7, pp 2384-2385

Khetrapal-CL, "NMR of Molecules Oriented in Liquid-Crystals - A Citation-Classic Commentary on the NMR-Spectrum of Pyridine Oriented in a Nematic Phase by Diehl,P., Khetrapal,C.L., and Kellerhals,H.P.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 20, pp 9-9

Kidd-T, "United-Kingdom-Serials-Group - 19th Annual Conference and Exhibition - Keele-University, Staffordshire, England, UK, 15-17-April-1996", LIBRARY ACQUISITIONS-PRACTICE AND THEORY 1996, Vol 20, Iss 4, pp 475-482

Kidwell-RE Kidwell-LA, "Evaluating Research on Electronic Surveillance - A Guide for Managers of Information Technology", INDUSTRIAL MANAGEMENT & DATA SYSTEMS 1996, Vol 96, Iss 1, pp 8+

Kiessling-J, "Hearing Instruments - A Look into the Future", FOLIA PHONIATRICA ET LOGOPAEDICA 1996, Vol 48, Iss 3, pp 156-162

Kikkawa-Y, "Studying the Lungs of the Young - A Citation-Classic Commentary on Study of Lungs of Fetal and NewbornRabbits -

Morphological, Biochemical and Surface Physical Development by Kikkawa,Y., Motoyama,E.K. and Gluck,L. and Type-II Epithelial-Cell of Lung .1. Method of Isolation by Kikkawa,Y. and Yoneda,K.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 38, pp 8-8

Kilgour-FG, "Effectiveness of Surname-Title-Words Searches by Scholars", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1995, Vol 46, Iss 2, pp 146-151

Kim-JH Michael-WB, "The Relationship of Creativity Measures to School-Achievement and to Preferred Learning and Thinking Style in a Sample of Korean High-School-Students", EDUCATIONAL AND PSYCHOLOGICAL MEASUREMENT,1995, Vol 55, Iss 1, pp 60-74

Kim-MT, "Publication Productivity of Part-Time Faculty at Schools of Library and Information-Science", JOURNAL OF EDUCATION FOR LIBRARY AND INFORMATION SCIENCE,1992, Vol 33, Iss 2, pp 159-163

Kim-MT, "Ranking of Journals in Library and Information-Science - A Comparison of Perceptual and Citation-Based Measures", COLLEGE & RESEARCH LIBRARIES,1991, Vol 52, Iss 1, pp 24-37

King-C, "Citation Analysis Reveals Top Canadian Universities in 20 Disciplines (Reprinted from Science Watch, Vol 6, November/December 1995)", SCIENTIST 1996, Vol 10, Iss 2, pp 13-13

King-C, "Inventors and Inventiveness - A Mix of Curiosity, Creativity, Paranoia, Persistence, and Illusions of Wealth", CURRENT CONTENTS,1991, Vol 5, Iss FEB, pp 6-13

Kingman-S, "Symposiums Published Without Peer-Review", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6861, pp 1049-1049

Kinnucan-MT, "Research and Evaluation for Information Professionals, by R.M. Losee, K.A. Worley", LIBRARY QUARTERLY,1994, Vol 64, Iss 1, pp 102-105

Kintsch-W, "The Long and Crooked Way Towards a Model of Text Comprehension - A Citation-Classic Commentary on Toward a Model of Text Comprehension and Production by Kintsch,W., and Vandijk,T.A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 34, pp 8-8

Kirman-A Dahl-M, "Economic Research in Europe", EUROPEAN ECONOMIC REVIEW,1994, Vol 38, Iss 3-4, pp 505-522

Kirschke-H, "Cathepsin-H Is One of the Lysosomal Cysteine Proteinases - A Citation-Classic Commentary on Cathepsin-H - An Endoaminopeptidase from Rat-Liver Lysosomes byKirschke,H., Langner,J., Wiederanders,B., Ansorge,S., Bohley,P., and Hanson,H.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 10, pp 10-10

Kishen-M Presho-M, "Emergency Contraception - A Prescription for Change", BRITISH JOURNAL OF FAMILY PLANNING 1996, Vol 22, Iss 1, pp 25-27

Kishida-K, "Quantitative Approaches to Library-Management - A Critical-Review", LIBRARY AND INFORMATION SCIENCE 1995, Iss 33, pp 39-69

Kisling-VN Haas-SC, "Wildlife Conservation Serials - An Analysis and Guide", SERIALS LIBRARIAN,1994, Vol 25, Iss 1-2, pp 145-156

Kister-J Pieri-N Quoniam-L Dou-H, "Bibliometric Tools Applied to Analytical-Chemistry - Example of UV Fluorescence Spectroscopy", ANALUSIS 1995, Vol 23, Iss 10, pp 518-522

Klaic-B, "Analysis of the Scientific Productivity of Researchers

from the Republic of Croatia for the Period 1990-,1992", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 133-152

Klebe-RJ Chen-T Ruddle-FH, "Production of Somatic-Cell Hybrids by Cell-Fusion - A Citation-Classic Commentary on Controlled Production of Proliferating Somatic-Cell Hybrids by Klebe,R.J., Chen,T.R., and Ruddle,F.H.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 34, pp 8-8

Klein-CN, "Benefits of Peer-Reviewed Publication", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1991, Vol 48, Iss 7, pp 1424-

Klein-WC Bloom-M, "Studies of Scholarly Productivity in Social-Work Using Citation Analysis", JOURNAL OF SOCIAL WORK EDUCATION,1992, Vol 28, Iss 3, pp 291-299

Klemola-E, "Cytomegalovirus as a Cause of Atypical Mononucleosis - A Citation-Classic Commentary on Cytomegalovirus as a Possible Cause of a Disease Resembling Infectious-Mononucleosis by Klemola,E., and Kaariainen,L. and Rise of Cytomegalovirus Antibodies in an Infectious-Mononucleosis-Like Syndrome After Transfusion by Kaariainen,L., Klemola,E., and Paloheimo,J.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 46, pp 10-10

Klette-TJ Griliches-Z, "The Inconsistency of Common Scale Estimators When Output Prices Are Unobserved and Endogenous", JOURNAL OF APPLIED ECONOMETRICS 1996, Vol 11, Iss 4, pp 343-361

Knafl-KA, "Qualitative Evaluation and Research Methods, Edition, by M.Q. Patton", RESEARCH IN NURSING & HEALTH,1991, Vol 14, Iss 1, pp 73-74

Knaus-WA, "Apache-II - A Prognostic Scoring System for Seriously Ill Hospitalized-Patients - A Citation-Classic Commentary on Apache-II - A Severity of DiseaseClassification-System by Knaus,W.A., Draper,E.A., Wagner,D.P., Zimmerman,J.E.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 48, pp 10-10

Knuth-DE, "Artistic Programming - A Citation-Classic Commentary on the Art of Computer-Programming, Vol 1, Fundamental Algorithms, Vol 2, Seminumerical Algorithms, Vol 3, Sorting and Searching by Knuth,D.E.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 34, pp 8-8

Koch-T, "Beyond Measurement - 4th-Generation Evaluation in Nursing", JOURNAL OF ADVANCED NURSING,1994, Vol 20, Iss 6, pp 1148-1155

Kolpin-VW Singell-LD, "The Gender Composition and Scholarly Performance of Economics Departments - A Test for Employment Discrimination", INDUSTRIAL & LABOR RELATIONS REVIEW 1996, Vol 49, Iss 3, pp 408-423

Koning-JW, "3 Other RS - Recognition, Reward and Resentment", RESEARCH-TECHNOLOGY MANAGEMENT,1993, Vol 36, Iss 4, pp 19-29

Kontorovich-V, "The Future of the Soviet Science", RESEARCH POLICY,1994, Vol 23, Iss 2, pp 113-121

Koopman-WJ, "Expressing Our Inner Thoughts - How to Organize and Write a Clinical Research-Project Grant Application", JOURNAL OF RHEUMATOLOGY,1992, Vol 19, Iss S33, pp 16-19

Koppelman-FS Bhat-CR Schofer-JL, "Market-Research Evaluation of Actions to Reduce Suburban Traffic Congestion - Commuter Travel Behavior and Response to Demand Reduction Actions", TRANSPORTATION

RESEARCH PART A-POLICY AND PRACTICE,1993, Vol 27, Iss 5, pp 383-393

Korevaar-JC Moed-HF, "Validation of Bibliometric Indicators in the Field of Mathematics", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 117-130

Korf-RP, "Simplified Author Citations for Fungi and Some Old Traps and New Complications", MYCOLOGIA 1996, Vol 88, Iss 1, pp 146-150

Koshland-DE, "Peer-Review or Performance Review - Reply", SCIENCE,1993, Vol 259, Iss 5091, pp 14-14

Koslakowicz-M Boehnke-K, "Emotional Jam - Suggestions for a Short Scale Based on the Propositions of Maaz,Hans,Joachim", GRUPPENPSYCHOTHERAPIE UND GRUPPENDYNAMIK,1993, Vol 29, Iss 2, pp 127-140

Kostrzewa-RM, "Pharmacology of 6-Hydroxydopamine - A Citation-Classic Commentary on Pharmacological Actions of 6-Hydroxydopamine by Kostrzewa,R.M., Jacobowitz,D.M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 32, pp 9-9

Kostyuk-PG, "Separation of Calcium Currents in Nerve-Cells - A Citation-Classic Commentary on Separation of Sodium and Calcium Currents in Somatic Membrane of Mollusk Neurons by Kostyuk,P.G., Krishtal,O.A., and Shakhovalov,Y.A.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 26, pp 8-8

Kozak-M, "Identifying Aug Initiator Codons - A Citation-Classic Commentary on Point Mutations Define a Sequence Flanking the Aug Initiator Codon That Modulates Translation by Eukaryotic Ribosomes - And on an Analysis of 5' Noncoding Sequences from 699 Vertebrate Messenger-RNAs by Kozak,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 40, pp 9-9

Krages-KP Yuefen-D Beck-JR, "A Citation Analysis of the Work of Lusted,Lee,B.", MEDICAL DECISION MAKING,1991, Vol 11, Iss 2, pp 116-118

Kramer-L Washo-CA, "Evaluation of a Court-Mandated Prevention Program for Divorcing Parents - The Children 1st Program", FAMILY RELATIONS,1993, Vol 42, Iss 2, pp 179-186

Kramer-TL Daniels-AS, "Results of Performance Indicators Survey of the National-Leadership-Council", BEHAVIORAL HEALTHCARE TOMORROW 1996, Vol 5, Iss 3, pp 59+

Krampen-G Wiesenhutter-J, "Bibliometric Findings on the Development of Subdisciplines of Psychology - History of International and German-Language Literature in the Area of Psychology", PSYCHOLOGISCHE RUNDSCHAU,1993, Vol 44, Iss 1, pp 25-34

Kranzberg-M, "Citation for Kranzberg,Melvin, ,1991 Bernal Prize Recipient - Acceptance", SCIENCE TECHNOLOGY & HUMAN VALUES,1992, Vol 17, Iss 3, pp 390-395

Kranzler-HR Kadden-RM Babor-TF Rounsaville-BJ, "Longitudinal, Expert, All Data Procedure for Psychiatric-Diagnosis in Patients with Psychoactive Substance Use Disorders", JOURNAL OF NERVOUS AND MENTAL DISEASE,1994, Vol 182, Iss 5, pp 277-283

Krause-N, "Early Parental Loss and Personal Control in Later Life", JOURNALS OF GERONTOLOGY,1993, Vol 48, Iss 3, pp P117-P126

Krauskopf-M, "Epistemometria, a Term Contributing to Express the Meaning and Potential Methodologies of Scientometrics in

Spanish-Speaking Countries", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 425-428

Krauskopf-M, "Scientometric Indicators as a Means to Assess the Performance of State Supported Universities in Developing-Countries - The Chilean Case", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 105-121

Krauskopf-M Mackenzie-MR Krauskopf-E Clavel-E Prat-AM, "Medical-Research in Chile - Quantitative Indicators", REVISTA MEDICA DE CHILE,1993, Vol 121, Iss 10, pp 1191-1203

Krefting-L, "Rigor in Qualitative Research - The Assessment of Trustworthiness", AMERICAN JOURNAL OF OCCUPATIONAL THERAPY,1991, Vol 45, Iss 3, pp 214-222

Kretschmer-H, "Coauthorship Networks of Invisible-Colleges and Institutionalized Communities", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 363-369

Kretschmer-H, "Measurement of Social-Stratification - A Contribution to the Dispute on the Ortega Hypothesis", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 97-113

Kretschmer-H, "Quantity and Quality in Science of Science", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 533-537

Kreuger-LW, "Should There Be a Moratorium on Articles That Rank Schools of Social-Work Based on Faculty Publications - Yes", JOURNAL OF SOCIAL WORK EDUCATION,1993, Vol 29, Iss 3, pp 240-245

Kreutzwiser-RD Slaats-MJ, "The Utility of Evaluation Research to Land-Use Regulations - The Case of Ontario Shoreline Development", APPLIED GEOGRAPHY,1994, Vol 14, Iss 2, pp 169-181

Krnjevic-K, "Amino-Acid Transmitters - A Citation-Classic Commentary on Iontophoretic Studies of Neurons in the Mammalian Cerebral-Cortex by Krnjevic,K., and Phillis,J.W.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 14, pp 11-11

Kroto-HW, "C-60 - The 3rd Man - A Citation-Classic Commentary on C-60 - Buckminsterfullerene by Kroto,H.W., Heath,J.R., Obrien,S.C., Curl,R.F., and Smalley,R.E.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 36, pp 8-9

Kruk-E, "The Disengaged Noncustodial Father - Implications for Social-Work-Practice with the Divorced Family", SOCIAL WORK,1994, Vol 39, Iss 1, pp 15-25

Krull-W, "The Max-Planck Experience of Evaluation", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 441-450

Kruuk-H, "Hunting Carnivores and Social Strategies - A Citation-Classic Commentary on the Spotted Hyena - A Study of Predation and Social-Behavior by Kruuk,H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 18, pp 10-10

Kuhlemeier-KV, "A Bibliometric Analysis of the Archives-of-Physical-Medicine-and-Rehabilitation", ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION,1992, Vol 73, Iss 2, pp 126-132

Kuhlmann-S, "German Government Departments Experience of RT-and-D Program-Evaluation and Methodology", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 461-471

Kuhlthau-CC, "Naturalistic Inquiry for Library-Science - Methods and Applications for Research, Evaluation, and Teaching, by C.A. Mellon", JOURNAL OF ACADEMIC LIBRARIANSHIP,1991, Vol 16, Iss 6, pp 369-369

Kumar-DD Helgeson-SL White-AL, "Computer-Technology Cognitive-Psychology Interface and Science Performance Assessment", ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT,1994, Vol 42, Iss 4, pp 6-16

Kundra-R, "Investigation of Collaborative Research Trends in Indian Kushner-S, "The Research Assessment Exercise Versus Development in Higher-Education - A Reply", BRITISH JOURNAL OF EDUCATIONAL STUDIES 1996, Vol 44, Iss 1, pp 5-8

Kunz-M, "About Metrics of Bibliometrics", JOURNAL OF CHEMICAL INFORMATION AND COMPUTER SCIENCES,1993, Vol 33, Iss 2, pp 193-196

Kunz-M, "Publish and Perish", CHEMICKE LISTY,1992, Vol 86, Iss 7, pp 527-530

Kushner-I, "The Acute Phase Response - A Citation-Classic Commentary on the Phenomenon of the Acute Phase Response by Kushner,I.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 28, pp 8-8

Kushner-I, "The Acute Phase Response - A Citation-Classic Commentary on the Phenomenon of the Acute Phase Response by Kushner,I.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 16, pp 8-8

Kutash-K Duchnowski-AJ Sondheimer-DL, "Building the Research Base for Childrens Mental-Health-Services", JOURNAL OF EMOTIONAL AND BEHAVIORAL DISORDERS,1994, Vol 2, Iss 4, pp 194-197

Kuwabara-T, "Biochemistry of Photosynthetic Water Oxidation - A Citation-Classic Commentary on Inactivation of Photosynthetic Oxygen Evolution and Concomitant Release of 3 Polypeptides in the Photosystem-II Particles of Spinach-Chloroplasts by Kuwabara,T., Murata,N.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 42, pp 8-8

Kyriakou-D, "Macroeconomic Aspects of S/T Program-Evaluation", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 451-459

Kyvik-S, "Popular Science Publishing", SCIENTOMETRICS,1994, Vol 31, Iss 2, pp 143-153

Kyvik-S Larsen-IM, "International Contact and Research Performance", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 161-172

Kyvik-S Smeby-JC, "Teaching and Research - The Relationship Between the Supervision of Graduate-Students and Faculty Research Performance", HIGHER EDUCATION,1994, Vol 28, Iss 2, pp 227-239

Kyvik-S Teigen-M, "Child-Care, Research Collaboration, and Gender Differences in Scientific Productivity", SCIENCE TECHNOLOGY & HUMAN VALUES 1996, Vol 21, Iss 1, pp 54-71

Laband-DN Piette-MJ, "Favoritism Versus Search for Good Papers - Empirical-Evidence Regarding the Behavior of Journal Editors", JOURNAL OF POLITICAL ECONOMY,1994, Vol 102, Iss 1, pp 194-203

Laband-DN Piette-MJ, "Does the Blindness of Peer-Review Influence Manuscript Selection Efficiency", SOUTHERN ECONOMIC JOURNAL,1994, Vol 60, Iss 4, pp 896-906

Laband-DN Piette-MJ, "A Citation Analysis of the Impact of Blinded Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 147-149

Lacey-C Longman-D, "The Press and Public-Access to the Environment and Development Debate", SOCIOLOGICAL REVIEW,1993, Vol 41, Iss 2, pp 207-243

Lachiusa-TA, "Development of the Graphic Social Network

Measure", JOURNAL OF SOCIAL SERVICE RESEARCH 1996, Vol 21, Iss 4, pp 1-35

Lacity-MC Feeny-DF, "In Search of Europe Information Technology Leaders - Review of Methods and Empirical-Evidence", INFORMATION SYSTEMS JOURNAL 1996, Vol 6, Iss 2, pp 85-108

Lacroix-EM, "Sail - Automating Interlibrary Loan", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1994, Vol 82, Iss 2, pp 171-175

Laduron-PM, "Spiperone - From Dopamine to Serotonin Receptors - A Citation-Classic Commentary on Spiperone - A Ligand of Choice for Neuroleptic Receptors .1. Kinetics and Characteristics of Invitro Binding by Leysen,J.E., Gommeren,W., and Laduron,P.M.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 40, pp 8-8

Lafollette-MC, "Measuring Equity - The United-States General Accounting Office Study of Peer-Review", SCIENCE COMMUNICATION,1994, Vol 16, Iss 2, pp 211-220

Laguardia-C Blake-M, "Chemistry Citation Index", LIBRARY JOURNAL,1994, Vol 119, Iss 21, pp 145-145

Lakhtin-GA, "2 Types of Scientific Products", VESTNIK ROSSIISKOI AKADEMII NAUK,1993, Vol 63, Iss 8, pp 701-704

Lalumiere-ML, "Increasing the Precision of Citations in Scientific Writing", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 8, pp 913-913

Lam-RW Elguebaly-N, "Research Funding of Psychiatric-Disorders in Canada - A Snapshot, 1990-,1991", CANADIAN JOURNAL OF PSYCHIATRY-REVUE CANADIENNE DE PSYCHIATRIE,1994, Vol 39, Iss 3, pp 141-146

Lambert-N, "Online Statistical Techniques as Patent Search Tools - Not for Patent Searchers Only .1. Patent Indexing, Patient Citations", DATABASE 1996, Vol 19, Iss 1, pp 74-78

Laming-D, "Why Is the Reliability of Peer-Review So Low", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 154-155

Lancaster-FW, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1409-1409

Lancaster-FW Burger-RH Rauchfuss-BM, "Use of Literature by East European Scientists - What Influences Place of Publication of Sources Cited", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 419-439

Lancaster-FW Bushur-S Low-YM, "Title: Kochen Influence Examined Bibliometrically", LIBRARY TRENDS, 1993, Vol 41, Iss 4, pp 549-566

Lancaster-FW Zeter-MJ Metzler-L, "Ranganathan Influence Examined Bibliometrically", LIBRI,1992, Vol 42, Iss 3, pp 268-281

LANCET, Citation Failures", LANCET,1991, Vol 337, Iss 8735, pp 230-230

Land-KC Mccall-PL Parker-KF, "Logistic Versus Hazards Regression-Analyses in Evaluation Research - An Exposition and Application to the North-Carolina Court Counselors Intensive Protective Supervision Project", EVALUATION REVIEW,1994, Vol 18, Iss 4, pp 411-437

Landry-R Traore-N Godin-B, "An Econometric-Analysis of the Effect of Collaboration on Academic Research Productivity", HIGHER EDUCATION 1996, Vol 32, Iss 3, pp 283-301

Landwirth-TK, "National-Library-of-Medicine Recommended Formats

for Bibliographic Citation, by K. Patrias", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1992, Vol 80, Iss 2, pp 205-206

Lane-DP, "Viral Oncogene Binds Host p53 Protein - A Citation-Classic Commentary on T-Antigen Is Bound to a Host Protein in SV40-Transformed Cells by Lane,D.P., and Crawford,L.V.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 24, pp 8-8

Lang-RE, "The Heart of the Matter - A Citation-Classic Commentary on Atrial Natiuretic Factor - A Circulating Hormone Stimulated by Volume Loading by Lang,R.E., Tholken,H.,Ganten,D., Luft,F.C., Ruskoaho,H.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 2, pp 8-8

Langham-T, "Consistency in Referencing", JOURNAL OF DOCUMENTATION 1995, Vol 51, Iss 4, pp 360-369

Laredo-P, "Structural Effects of EC RT-and-D Programs", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 473-487

Larkin-E Close-A, "Performing Well - Referrals to Rampton-Hospital in 1993", JOURNAL OF FORENSIC PSYCHIATRY 1996, Vol 7, Iss 1, pp 177-184

Larson-JS Kershaw-R, "Rating Journals in Health-Care Administration by the Textbook Citation Method", MEDICAL CARE,1993, Vol 31, Iss 11, pp 1057-1061

Larson-RL, "Competing Paradigms for Research and Evaluation in the Teaching of English", RESEARCH IN THE TEACHING OF ENGLISH,1993, Vol 27, Iss 3, pp 283-292

Larson-RR, "Bibliometrics of the World-Wide-Web - An Exploratory Analysis of the Intellectual Structure of Cyberspace", PROCEEDINGS OF THE ASIS ANNUAL MEETING 1996, Vol 33, pp 71-78

Larsson-LI, "Cholecystokinin Nerves - A Citation-Classic Commentary on Localization and Molecular Heterogeneity of Cholecystokinin in the Central and Peripheral Nervous-System by Larsson,L.I., and Rehfeld,J.F.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 46, pp 10-10

Larsson-LI Sundler-F, "Peptides in Nerve-Cells - A Citation-Classic Commentary on Localization of Vasoactive Intestinal Polypeptide (VIP) to Central and Peripheral Neurons by Larsson,L.I., Fahrenkrug,J.,Demuckadell,Schaffalitzky,O.,Sundler,F.,Hakanson,R., and Rehfeld,J.F.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 48, pp 8-8

Larsson-LI Sundler-F, "New Cell Type in the Islets of Langerhans - A Citation-Classic Commentary on Pancreatic-Polypeptide - A Postulated New Hormone - Identification of Its Cellular-Storage Site by Light and Electron-Microscopic Immunocytochemistry by Larsson,L.I., Sundler,F. and Hakanson,R.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 50, pp 8-8

Laties-VG Mace-FC, "Taking Stock - The 1st 25 Years of the Journal of Applied Behavior Analysis", JOURNAL OF APPLIED BEHAVIOR ANALYSIS,1993, Vol 26, Iss 4, pp 513-525

Lauer-G, "Results of Quality-of-Life Research on Chronic Mentally-Ill Patients", PSYCHIATRISCHE PRAXIS,1993, Vol 20, Iss 3, pp 88-90

Lauren-PA, "The Lauren Classification of Gastric-Cancer - A Citation-Classic Commentary on the 2 Histological Main Types of

Gastric-Carcinoma - Diffuse and So-Called Intestinal-Type Carcinoma by Lauren,P.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 34, pp 8-8

Lauritzen-F Hoffmann-AN, "Does Traditional Wage Competitiveness Measure the Success of Industrial-Policy", NATIONALOKONOMISK TIDSSKRIFT 1996, Vol 134, Iss 2, pp 175-190

Lavelle-JM Hovell-MF West-MP Wahlgren-DR, "Promoting Law-Enforcement for Child Protection - A Community Analysis", JOURNAL OF APPLIED BEHAVIOR ANALYSIS,1992, Vol 25, Iss 4, pp 885-892

Law-J Whittaker-J, "Mapping Acidification Research - A Test of the CO-Word Method", SCIENTOMETRICS,1992, Vol 23, Iss 3, pp 417-461

Lawless-C, "Investigating the Cognitive Structure of Students Studying Quantum-Theory in an Open-University History of Science Course - A Pilot-Study", BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY,1994, Vol 25, Iss 3, pp 198-216

Lawlor-B, "Electronic Publishing - Copyright Concerns from the Perspective of a Secondary Information Publisher", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 15-CINF

Lawson-M, "Citation Analysis Confirms Australian Sciences Declining Influence", NATURE,1994, Vol 370, Iss 6485, pp 86-86

Lawson-M Kemp-N Lynch-MF Chowdhury-GG, "Automatic Extraction of Citations from the Text of English-Language Patents - An Example of Template Mining", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 6, pp 423-436

Lawton-J, "Peer-Review, Coevolution and Tortoises", OIKOS,1994, Vol 69, Iss 3, pp 361-363

Lazarev-VS, "Notion of a Document - A Center of Gravity Attraction for Getting Metricians Together", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 511-516

Lazarev-VS, "On Chaos in Bibliometric Terminology", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 271-277

Leach-MK, "Primary Nursing - Autonomy or Autocracy", JOURNAL OF ADVANCED NURSING,1993, Vol 18, Iss 3, pp 394-400

Leao-AAP, "Remarkable Reaction of the Brain Gray-Matter - A Citation-Classic Commentary on Spreading Depression of Activity in the Cerebral-Cortex by Leao,A.A.P.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 38, pp 8-8

Leckie-GJ, "Desperately Seeking Citations - Uncovering Faculty Assumptions About the Undergraduate Research Process", JOURNAL OF ACADEMIC LIBRARIANSHIP 1996, Vol 22, Iss 3, pp 201-208

Leclerc-M Gagne-J, "International Scientific Cooperation - The Continentalization of Science", SCIENTOMETRICS,1994, Vol 31, Iss 3, pp 261-292

Lecompte-MD, "Sensible Matchmaking - Qualitative Research Design and the Program-Evaluation Standards", JOURNAL OF EXPERIMENTAL EDUCATION,1994, Vol 63, Iss 1, pp 29-43

Ledbetter-MF Smith-LA Voslerhunter-WL Fischer-JD, "An Evaluation of the Research and Clinical Usefulness of the Spiritual Well-Being Scale", JOURNAL OF PSYCHOLOGY AND THEOLOGY,1991, Vol 19, Iss 1, pp 49-55

Ledley-FD, "The Quality of Medical Science", CLINICAL AND

INVESTIGATIVE MEDICINE-MEDECINE CLINIQUE ET EXPERIMENTALE,1992, Vol 15, Iss 6, pp 513-517

Ledley-FD Lovejoy-FH, "Prospects for Academically Trained Pediatricians in Academic Medicine", CLINICAL AND INVESTIGATIVE MEDICINE-MEDECINE CLINIQUE ET EXPERIMENTALE,1992, Vol 15, Iss 6, pp 518-526

Lee-A Parker-G, "The Peer-Review of Outcome of Depression in Psychiatric Settings", BRITISH JOURNAL OF PSYCHIATRY,1994, Vol 164, Iss MAR, pp 305-308

Lee-DR, "Evaluating Research Impacts - Workshop on the Assessment of International Agricultural-Research Impacts for Sustainable Development, Organized by Cornell-International-Institute-for-Food-Agriculture-and-Development (Ciifad), Ithaca, NY, 17-19 June ,1991", FOOD POLICY,1992, Vol 17, Iss 1, pp 87-89

Lee-JT, "Making Peer-Review Statistically Accountable", AMERICAN JOURNAL OF SURGERY 1996, Vol 172, Iss 2, pp 222-224

Lee-O Fradd-SH, "Literacy Skills in Science Learning Among Linguistically Diverse Students", SCIENCE EDUCATION 1996, Vol 80, Iss 6, pp 651-671

Lee-VE Burkam-DT, "Gender Differences in Middle Grade Science Achievement - Subject Domain, Ability Level, and Course Emphasis", SCIENCE EDUCATION 1996, Vol 80, Iss 6, pp 613-650

Leemans-MJ Maes-M Rousseau-R Ruts-C, "The Negative Binomial-Distribution as a Trend Distribution for Circulation Data in Flemish Public-Libraries", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 47-57

Lefevre-F Feinglass-J Yarnold-PR Martin-GJ Webster-J, "Use of the Rand Structured Implicit Review Instrument for Quality of Care Assessment", AMERICAN JOURNAL OF THE MEDICAL SCIENCES,1993, Vol 305, Iss 4, pp 222-228

Leff-JP, "A New Treatment for Schizophrenia - A Citation-Classic Commentary on a Controlled Trial of Social-Intervention in the Families of Schizophrenic-Patients by Leff,J., Kuipers,L., Berkowitz,R., Eberleinvries,R. and Sturgeon,D.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 24, pp 8-8

Lehnen-RG, "Constructing State Education Performance Indicators from Act and Sat Scores", POLICY STUDIES JOURNAL,1992, Vol 20, Iss 1, pp 22-40

Lehnen-RG Mcgregor-EM, "Human-Capital Report Cards for American States", POLICY SCIENCES,1994, Vol 27, Iss 1, pp 19-35

Leibenluft-E Dial-TH Haviland-MG Pincus-HA, "Sex-Differences in Rank Attainment and Research Activities Among Academic Psychiatrists", ARCHIVES OF GENERAL PSYCHIATRY,1993, Vol 50, Iss 11, pp 896-904

Leibowitz-HW, "The Symbiosis Between Basic and Applied-Research", AMERICAN PSYCHOLOGIST 1996, Vol 51, Iss 4, pp 366-370

Lemarc-M Courtial-JP Senkovska-ED Petard-JP Py-Y, "The Dynamics of Research in the Psychology of Work from 1973 to 1987 - From the Study of Companies to the Study of Professions", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 69-86

Leminor-S Dostatni-P, "A Bibliometric Study of the Publications of the French-National-Institute-for-Health-and-Medical-Research (Inserm)", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 41-63

Lemoine-W, "Productivity Patterns of Men and Women Scientists in Venezuela", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 281-295

Lemoine-W, "The Frequency-Distribution of Research Papers andPatents According to Sex - The Case of Csir - India", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 449-469

Lenzini-RT Shaw-W, "Uncover and Uncover2 - An Article Citation Database and Service Featuring Document Delivery", INTERLENDING & DOCUMENT SUPPLY,1992, Vol 20, Iss 1, pp 12-15

Leonard-J, "An Analysis of Citations to Authority in Ohio Appellate Decisions Published in 1990", LAW LIBRARY JOURNAL,1994, Vol 86, Iss 1, pp 129-155

Leopard-PJ, "Citation for the Presentation of the 1990 Thackray Surgical Prize to Wardbooth,R.P.", BRITISH JOURNAL OF ORAL & MAXILLOFACIAL SURGERY,1992, Vol 30, Iss 3, pp 200-200

Lepair-C, "Formal Evaluation Methods - Their Utility and Limitations", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION 1995, Vol 20, Iss 4, pp 16-24

Lepair-C, "Puberty or Midlife Crisis", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 517-520

Lepkowski-W, "Science Indicators 1996 - Report Probes Trends, Public Attitude", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 22, pp 4-5

Leta-J Demeis-L, "A Profile of Science in Brazil", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 33-44

Leukefeld-CG Tims-FR, "Drug-Abuse Treatment in Prisons and Jails", JOURNAL OF SUBSTANCE ABUSE TREATMENT,1993, Vol 10, Iss 1, pp 77-84

Levallois-P Gaudreault-P Rhainds-M Weber-JP, "Is There a Need for Systematic Blood Lead Screening in Canadian Children", CANADIAN JOURNAL OF PUBLIC HEALTH-REVUE CANADIENNE DE SANTE PUBLIQUE,1994, Vol 85, Iss 3, pp 167-170

Lever-ABP, "Comprehensible Electronic-Structure - A Citation-Classic Commentary on Inorganic Electronic Spectroscopy by Lever,A.B.P.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 42, pp 11-11

Levi-M, "The Use and Misuse of Citations as a Measure of Influence in Criminology", BRITISH JOURNAL OF CRIMINOLOGY,1995, Vol 35, Iss 1, pp 138-142

Levin-SA, "Orchestrating Environmental-Research and Assessment", ECOLOGICAL APPLICATIONS,1992, Vol 2, Iss 2, pp 103-106

Levin-SG Stephan-PE, "Research Productivity over the Life-Cycle - Evidence for Academic Scientists", AMERICAN ECONOMIC REVIEW,1991, Vol 81, Iss 1, pp 114-132

Levinson-EM Barker-W Lillenstein-D, "Publication Productivity in Selected School-Psychology Journals - A Reconsideration Based on Institutional Mission", PSYCHOLOGY IN THE SCHOOLS,1994, Vol 31, Iss 2, pp 120-127

Levitt-SW, "Quality of Care and Investment in Property, Plant, and Equipment in Hospitals", HEALTH SERVICES RESEARCH,1994, Vol 28,

Iss 6, pp 713-727

Lewis-IH, "Peer-Reviewed Anesthesiology Journals and Research", ANESTHESIA AND ANALGESIA,1992, Vol 75, Iss 1, pp 155-156

Lewis-R, "Performance Indicators in Higher-Education, by J. Johnes, J. Taylor", STUDIES IN HIGHER EDUCATION,1992, Vol 17, Iss 1, pp 111-113

Lewis-RK Paineandrews-A Fawcett-SB Francisco-VT Richter-KP Copple-B Copple-JE, "Evaluating the Effects of a Community Coalitions Efforts to Reduce Illegal Sales of Alcohol and Tobacco Products to Minors", JOURNAL OF COMMUNITY HEALTH 1996, Vol 21, Iss 6, pp 429-436

Lewison-G, "Publications from the European-Community Biotechnology Action Program (Bap) - Multinationality, Acknowledgment of Support, and Citations", SCIENTOMETRICS,1994, Vol 31, Iss 2, pp 125-142

Lewison-G, "The Contribution of European-Community Less Favored Region Research Outputs to Economic and Social Cohesion", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 217-229

Lewison-G, "The Scientific Output of the Ecs Less Favored Regions", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 383-402

Lewison-G Cunningham-P, "Bibliometric Studies for the Evaluation of Trans-National Research", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 223-244

Lewison-G Fawcettjones-A Kessler-C, "Latin-American Scientific Output 1986-91 and International Co-Authorship Patterns", SCIENTOMETRICS,1993, Vol 27, Iss 3, pp 317-336

Leyden-DP Link-AN, "Tax Policies Affecting Research-and-Development - An International Comparison", TECHNOVATION,1993, Vol 13, Iss 1, pp 17-25

Leyden-DP Link-AN, "Privatization, Bureaucracy, and Risk-Aversion", PUBLIC CHOICE,1993, Vol 76, Iss 3, pp 199-213

Leydesdorff-L, "A Validation-Study of Leximappe", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 295-312

Leydesdorff-L, "A Validation-Study of Leximappe - Reply", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 317-319

Leydesdorff-L, "Irreversibilities in Science and Technology Networks - An Empirical and Analytical Approach", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 321-357

Leydesdorff-L, "On the Scientometric Decline of British Science - One Additional Graph in Reply to Martin,Ben", SCIENTOMETRICS,1991, Vol 20, Iss 2, pp 363-367

Leydesdorff-L, "Scientometrics - French, by M. Callon, J.P. Courtial, H. Penan", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 539-541

Leydesdorff-L, "The Generation of Aggregated Journal-Journal Citation Maps on the Basis of the Cd-ROM Version of the Science-Citation-Index", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 59-84

Leydesdorff-L Cozzens-SE, "The Delineation of Specialities in Terms of Journals Using the Dynamic Journal Set of the Sci", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 135-156

Leydesdorff-L Cozzens-S Vandenbesselaar-P, "Tracking Areas of Strategic Importance Using Scientometric Journal Mappings", RESEARCH POLICY,1994, Vol 23, Iss 2, pp 217-229

Leydesdorff-L Gauthier-L, "The Evaluation of National Performance in Selected Priority Areas Using Scientometric Methods", RESEARCH POLICY 1996, Vol 25, Iss 3, pp 431-450

Leydesdorff-L Wouters-P, "Crisis or Critique", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 433-437

Li-YY Tougas-G Chiverton-SG Hunt-RH, "The Effect of Acupuncture on Gastrointestinal Function and Disorders", AMERICAN JOURNAL OF GASTROENTEROLOGY,1992, Vol 87, Iss 10, pp 1372-1381

Liang-LM Zhao-HZ Wang-Y Wu-YS, "Distribution of Major Scientific and Technological Achievements in Terms of Age Group - Weibull Distribution", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 3-18

Liberatore-MJ Nydick-RL Sanchez-PM, "The Evaluation of Research Papers (or How to Get an Academic Committee to Agree on Something)", INTERFACES,1992, Vol 22, Iss 2, pp 92-100

Liberman-S, "The Role of Informal Communication in Scientific Productivity", INTERNATIONAL JOURNAL OF PSYCHOLOGY 1996, Vol 31, Iss 3-4, pp 1524-1524

Lichbach-MI, "Nobody Cites Nobody Else - Mathematical-Models of Domestic Political-Conflict", DEFENCE ECONOMICS,1992, Vol 3, Iss 4, pp 341-357

Lichter-PR, "Demystifying the Peer-Review Process", OPHTHALMOLOGY,1993, Vol 100, Iss 12, pp 1749-1750

Lifshin-A, "Citation Analysis of Geochimica-Et-Cosmochimica-Acta, 1951-1960", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1993, Vol 44, Iss 6, pp 322-326

Lighthill-MJ, "Flow Noise Science - A Citation-Classic Commentary on on Sound Generated Aerodynamically by Lighthill,M.J.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 36, pp 8-8

Likierman-A, "Performance Indicators - 20 Early Lessons from Managerial Use", PUBLIC MONEY & MANAGEMENT,1993, Vol 13, Iss 4, pp 15-22

Liming-L Lihua-L, "Scientific Publication Activities of 32 Countries - Zipf-Pareto Distribution", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 263-273

Lin-CC, "Patient Satisfaction with Nursing-Care as an Outcome Variable - Dilemmas for Nursing Evaluation Researchers", JOURNAL OF PROFESSIONAL NURSING 1996, Vol 12, Iss 4, pp 207-216

Linardi-PM Coelho-PMZ Costa-HMA, "The Impact Factor as a Criterion for the Quality of Scientific Production Is a Relative, Not Absolute, Measure", BRAZILIAN JOURNAL OF MEDICAL AND BIOLOGICAL RESEARCH 1996, Vol 29, Iss 5, pp 555-561

Lindahl-BIB Welljamsdorof-A, "Estimating Popper Impact", NATURE,1992, Vol 360, Iss 6401, pp 204-204

Lindberg-B, "Structural-Analysis of Polysaccharides - A Citation-Classic Commentary on Gas-Liquid-Chromatography and Mass-Spectrometry in Methylation Analysis of Polysaccharides by Bjorndal,H., Hellerqvist,C.G., Lindberg,G., Svensson,S.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 10, pp 10-10

Lindhard-J, "Theory of String Effect and Channeling - A Citation-Classic Commentary on Influence of Crystal-Lattice on Motion

of Energetic Charged-Particles by Lindhard,J.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 6, pp 8-8

Lindholmromantschuk-Y Warner-J, "The Role of Monographs in Scholarly Communication - An Empirical-Study of Philosophy, Sociology and Economics", JOURNAL OF DOCUMENTATION 1996, Vol 52, Iss 4, pp 389-404

Lindsey-D, "Precision in the Manuscript Review Process - Hargens and Herting Revisited", SCIENTOMETRICS,1991, Vol 22, Iss 2, pp 313-325

Lindsey-D, "The Relationship Between Performance Indicators for Academic Research and Funding - Developing a Measure of Return on Investment in Science", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 221-234

Lindzen-RS, "Gravity-Wave Breaking - Legitimizing Popular Fudges - A Citation-Classic Commentary on Turbulence and Stress Owing to Gravity-Wave and Tidal Breakdown by Lindzen,R.S.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 24, pp 8-8

Lindzen-RS, "Legitimizing Popular Fudges - A Citation-Classic Commentary on Turbulence and Stress Owing to Gravity-Wave and Tidal Breakdown by Lindzen,R.S.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 24, pp 8-8

Line-MB, "Changes in the Use of Literature with Time - Obsolescence Revisited", LIBRARY TRENDS,1993, Vol 41, Iss 4, pp 665-683

Line-MB, "Fallacies Noted in Article on Citation Patterns", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1993, Vol 81, Iss 4, pp 442-442

Link-AN, "Economic-Performance Measures for Evaluating Government-
Sponsored Research", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 325-342

Link-AN, "On the Classification of Industrial R-and-D", RESEARCH POLICY 1996, Vol 25, Iss 3, pp 397-401

Link-AN, "Research Joint Ventures - Patterns from Federal Register Filings", REVIEW OF INDUSTRIAL ORGANIZATION 1996, Vol 11, Iss 5, pp 617-628

Link-AN, "The Use of Literature-Based Innovation Output Indicators for Research Evaluation", SMALL BUSINESS ECONOMICS 1995, Vol 7, Iss 6, pp 451-455

Link-AN Kapur-P, "A Note on the Diffusion of Flexible Manufacturing Systems Technology", ECONOMICS LETTERS,1994, Vol 46, Iss 4, pp 369-374

Link-AN Quick-P Tassey-G, "Investments in Product Quality - A Descriptive Study of the United-States Optical Fiber Industry", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE,1991, Vol 19, Iss 5, pp 471-474

Link-AN Scott-JT, "Market Failure in High-Technology Industries - Government and Industry Responses - Introduction", REVIEW OF INDUSTRIAL ORGANIZATION 1996, Vol 11, Iss 5, pp 575-578

Link-AN Tassey-G, "The Technology Infrastructure of Firms - Investments in Infratechnology", IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT,1993, Vol 40, Iss 3, pp 312-315

Link-AN Teece-DJ Finan-WF, "Estimating the Benefits from Collaboration - The Case of Sematech", REVIEW OF INDUSTRIAL ORGANIZATION 1996, Vol 11, Iss 5, pp 737-751

Linkowski-DC Thoreson-RW Diamond-EE Leahy-MJ Szymanski-EM Witty-T, "Instrument to Validate Rehabilitation Counseling Accreditation and Certification Knowledge Areas", REHABILITATION COUNSELING BULLETIN,1993, Vol 37, Iss 2, pp 123-129

Lippincott-JW, "A Better Citation System - Reply", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 614-614

Lipschutz-ME, "Leonard Medal Citation for Begemann,F. - 1995 September 13, Washington, DC", METEORITICS & PLANETARY SCIENCE 1996, Vol 31, Iss 2, pp 169-170

Lipsey-MW, "Key Issues in Intervention Research - A Program-Evaluation Perspective", AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 1996, Vol 29, Iss 4, pp 298-302

Lipton-D, "How to Maximize Utilization of Evaluation Research by Policy-Makers", ANNALS OF THE AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE,1992, Vol 521, Iss MAY, pp 175-188

Lithgow-SD Hepworth-JB, "Performance-Measurement in Prison Libraries - Research Methods, Problems and Perspectives", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE,1993, Vol 25, Iss 2, pp 61-69

Liu-MX, "A Study of Citing Motivation of Chinese Scientists", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 1, pp 13-23

Liu-MX, "Progress in Documentation - The Complexities of CitationPractice - A Review of Citation Studies", JOURNAL OF DOCUMENTATION,1993, Vol 49, Iss 4, pp 370-408

Lloyd-M Prestonshoot-M Temple-B Wuu-R, "Whose Project Is It Anyway - Sharing and Shaping the Research-and-Development Agenda", DISABILITY & SOCIETY 1996, Vol 11, Iss 3, pp 301-315

Lloyd-S, "Family Sexual Abuse - Frontline Research and Evaluation, by M.Q. Patton", BRITISH JOURNAL OF SOCIAL WORK,1992, Vol 22, Iss 5, pp 605-607

Loach-J Oxford-L, "Research and Evaluation - The Involvement of Community Dietitians", JOURNAL OF HUMAN NUTRITION AND DIETETICS,1994, Vol 7, Iss 5, pp 377-389

Lobdell-DD, "Research Benefits", NATURE,1993, Vol 361, Iss 6410, pp 292-292

Lock-S, "Does Editorial Peer-Review Work", ANNALS OF INTERNAL MEDICINE,1994, Vol 121, Iss 1, pp 60-61

Lock-S, "Peer-Review of Submitted Papers", MEDICINA CLINICA,1992, Vol 98, Iss 8, pp 304-305

Lock-S, "The Grossest Failures of Peer-Review", BRITISH MEDICAL JOURNAL,1993, Vol 307, Iss 6900, pp 382-382

Locke-EA Latham-GP, "Goal-Setting Theory - A Citation-Classic Commentary on Goal-Setting and Task-Performance by Locke,E.A., Saari,L.M., Shaw,K.N. and Latham,G.P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 32, pp 8-8

Lockett-MW Khawam-YJ, "Referencing Patterns in C-and-RL and Jal, 1984-1986 - A Bibliometric Analysis", LIBRARY & INFORMATION SCIENCE RESEARCH1990, Vol 12, Iss 3, pp 281-289

Loehle-C, "A Critical Path-Analysis of Scientific Productivity", JOURNAL OF CREATIVE BEHAVIOR,1994, Vol 28, Iss 1, pp 33-47

Logan-EL Shaw-WM, "A Bibliometric Analysis of Collaboration in a Medical Specialty", SCIENTOMETRICS,1991, Vol 20, Iss 3, pp 417-426

Long-J, "NSF Tries to Measure Research Productivity", CHEMICAL & ENGINEERING NEWS,1994, Vol 72, Iss 40, pp 26-26

Long-JS, "Measures of Sex-Differences in Scientific Productivity (Reprinted from Social Forces, Vol 71, Pg 159-178, ,1992)", CURRENT CONTENTS,1993, Vol 11, Iss MAR, pp 4-13

Long-JS, "Measures of Sex-Differences in Scientific Productivity", SOCIAL FORCES,1992, Vol 71, Iss 1, pp 159-178

Longley-P Martin-D Higgs-G, "The Geographical Implications of Changing Local Taxation Regimes", TRANSACTIONS OF THE INSTITUTE OF BRITISH GEOGRAPHERS,1993, Vol 18, Iss 1, pp 86-101

Lopez-M, "Using Performance Indicators to Guide Strategic Decision-
Making, by V.M.H. Borden, T.W. Banta", JOURNAL OF COLLEGE STUDENT DEVELOPMENT 1996, Vol 37, Iss 3, pp 354-355

Lopezmunoz-F Boya-J Marin-F Calvo-JL, "Scientific-Research on the Pineal-Gland and Melatonin - A Bibliometric Study for the Period 1966-1994", JOURNAL OF PINEAL RESEARCH 1996, Vol 20, Iss 3, pp 115-124

Louw-J Katzenellenbogen-J Carolissen-R, "Community-Health Needs, Community Participation, and Evaluation Research", EVALUATION AND PROGRAM PLANNING 1995, Vol 18, Iss 4, pp 365-369

Lovisolo-H, "The Legitimation of Science on the Frontier", DADOS-REVISTA DE CIENCIAS SOCIAIS,1994, Vol 37, Iss 2, pp 161-178

Lowe-I, "How Effective Are Cooperative Research Centers - Critical Mass and Research Output - A Myth Dispelled", SEARCH,1993, Vol 24, Iss 9, pp 242-243

Lowe-RB Awad-N Gonzalez-M Rosso-P, "Nonverbal Hypermedia for Chemical Information", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1992, Vol 204, Iss AUG, pp 10-CINF

Lowenthal-D, "Citation Solecisms", AREA,1992, Vol 24, Iss 3, pp 320-321

Lowry-PS Walker-CS, "The Need to Evaluate Research Support Offices in Institutions of Higher-Education", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS,1992, Vol 23, Iss 4, pp 35-41

Lu-AYH, "From Microsomes to Purified Cytochrome-P-450 - A Citation-Classic Commentary on Role of Hemoprotein-P-450 in Fatty-Acid W-Hydroxylation in a Soluble Enzyme-System from Liver-Microsomes by Lu,A.Y.H., and Coon,M.J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 10, pp 11-11

Luce-BR Lyles-CA Rentz-AM, "The View from Managed Care Pharmacy", HEALTH AFFAIRS 1996, Vol 15, Iss 4, pp 168-176

Luce-RD, "Reliability Is Neither to Be Expected Nor Desired inPeer-Review", BEHAVIORAL AND BRAIN SCIENCES,1993, Vol 16, Iss 2, pp 399-400

Luehing-C, "Peer-Review", WATER ENVIRONMENT RESEARCH,1993, Vol 65, Iss 6, pp 707-707

Luehrs-DC Brown-RE, "Is College-Teaching Quality Influenced by Research Activity of the Instructor", JOURNAL OF CHEMICAL EDUCATION,1992, Vol 69, Iss 1, pp 35-36

Lugmair-GW, "Leonard Medal Citation for Clayton,Donald,D. - 25

July ,1991 Monterey, California USA", METEORITICS,1992, Vol 27, Iss 1, pp 4-4

Lundberg-GD, "The Jama 1995 Editorial Peer-Review Audit", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 1996, Vol 275, Iss 10, pp 804-804

Lundberg-GD Glass-RM, "What Does Authorship Mean in a Peer-Reviewed Medical Journal", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 1996, Vol 276, Iss 1, pp 75-75

Lundberg-GD Williams-E, "The Quality of a Medical Article - Thank-You to Our 1990 Peer Reviewers", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1991, Vol 265, Iss 9, pp 1161-1162

Luttgau-HC, "Ca/Na Antagonism in the Frogs Heart - A Citation-Classic Commentary on the Antagonism Between Ca and Na Ions on the Frogs Heart by Luttgau,H.C., Niedergerke,R.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 44, pp 10-10

Luukkonen-T, "Are We Longing for the Golden Era Lost or for the One to Come", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 481-485

Luukkonen-T, "Is Scientists Publishing Behavior Reward-Seeking", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 297-319

Luukkonen-T Tijssen-RJW Persson-O Sivertsen-G, "The Measurement of International Scientific Collaboration", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 15-36

Luzar-V Dobric-V Maricic-S Pifat-G Spaventi-J, "A Methodology for Cluster-Analysis of Citation Histories", QUALITY & QUANTITY,1992, Vol 26, Iss 4, pp 337-365

Lyddon-WJ Bradford-E Nelson-JP, "Assessing Adolescent and Adult Attachment - A Review of Current Self-Report Measures", JOURNAL OF COUNSELING AND DEVELOPMENT,1993, Vol 71, Iss 4, pp 390-395

Lyell-A, "Smoke Without Fire - A Citation-Classic Commentary on Toxic Epidermal Necrolysis - An Eruption Resembling Scalding of the Skin by Lyell,A.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 16, pp 8-8

Lykken-DT, "Palmar Sweating - Its Measurement and Meaning - A Citation-Classic Commentary on Direct Measurement of Skin-Conductance - A Proposal for Standardization by Lykken,D.T., and Venables,P.H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 4, pp 8-8

Lynch-JC, "Parietal Association Cortex - Sensory or Beyond - A Citation-Classic Commentary on the Posterior Parietal Association Cortex of the Monkey - Command Functions for Operations Within Extrapersonal Space by Mountcastle,V.B., Lynch,J.C., Georgopoulos,A., Sakata,H. and Acuna,C. Parietal Lobe Mechanisms for Directed Visual-Attention by Lynch,J.C., Mountcastle,V.B., Talbot,W.H. and Yin,T.C.T. and the Functional-Organization of Posterior Parietal Association Cortex by Lynch,J.C.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 14, pp 10-10

Lyons-JM, "On Comparing Apples and Oranges - Chilling Injury Revisited - A Citation-Classic Commentary on Chilling Injury in Plants by Lyons,J.M.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 34, pp 8-8

Lyons-M, "Process over Person - Occupational-Therapy Students Fieldwork Experiences of People in Psychiatric Settings", DISABILITY AND REHABILITATION 1996, Vol 18, Iss 4, pp 197-204

Maack-T Atlas-SA, "The Ways of a New Hormone - A Citation-Classic Commentary on Effects of Auriculin (Atrial-Natriuretic-Factor) on Blood-Pressure, Renal-Function, and the Reninaldosterone System in Dogs by Maack,T., Marion,D.N., Camargo,M.J.F., Kleinert,H.D., Laragh,J.H., Vaughan,E.D., Atlas,S.A.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 48, pp 8-8

Macdermott-RP, "Fraudulent Research in Science - The Responsibility of the Peer Reviewer", CANCER INVESTIGATION,1991, Vol 9, Iss 6, pp 703-705

Maciaschapula-CA, "Non-Sci Subject Visibility of the Latin-American Scientific Production in the Health Field", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 97-104

Maciaschapula-CA, "Patterns of Scientific Communication Among Latin-American Countries, in the Field of Medical-Education", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 123-135

Macilwain-C, "As Citation Landscape Takes Shape", NATURE 1996, Vol 383, Iss 6602, pp 659-659

Macilwain-C, "Settlement Deprives Peer-Review of Its Day in Court", NATURE 1996, Vol 384, Iss 6604, pp 4-4

Macilwain-C, "United-States Agencies Urged to Tighten Up Peer-Review", NATURE,1993, Vol 364, Iss 6437, pp 470-470

Mackin-N Stephens-CD, "Evaluation of an Orthodontic Expert-System by Peer-Review Trial", JOURNAL OF DENTAL RESEARCH 1996, Vol 75, Iss 5, pp 1200-1200

Maclean-J Janagap-C, "The Publication Productivity of International Agricultural-Research Centers", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 329-348

Macpherson-RJS, "Educative Accountability Policy Research - Methodology and Epistemology", EDUCATIONAL ADMINISTRATION QUARTERLY 1996, Vol 32, Iss 1, pp 80-106

Macroberts-MH Macroberts-BR, "Problems of Citation Analysis", SOCIAL WORK RESEARCH & ABSTRACTS,1992, Vol 28, Iss 4, pp 4-4

Macroberts-MH Macroberts-BR, "Problems of Citation Analysis", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 435-444

Maczelka-H Zsindely-S, "All Well if Starts Well - Citation Infancy of Recently Launched Chemistry Journals", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 367-372

Maddala-GS, "Econometrics with Partial Observability - A Citation-Classic Commentary on Limited Dependent and Qualitative Variables in Econometrics by Maddala,G.S.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 30, pp 8-8

Maeda-H, "High-Tc Bi-Based Oxide Superconductors - A Citation-Classic Commentary on a New High-Tc Oxide Superconductor Without a Rare-Earth Element by Maeda,H., Tanaka,Y., Fukutomi,M., Asano,T.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 16, pp 8-8

Magee-LA Koren-G, "The Use of Teratogen Information-Services for Research - Assessment of Reliability of Data-Entry", REPRODUCTIVE TOXICOLOGY,1994, Vol 8, Iss 5, pp 419-424

Magnan-S Warren-JB, "Internal-Medicine Resident and Faculty Attitudes Toward Peer-Review", CLINICAL RESEARCH,1994, Vol 42, Iss 3, pp A369-A369

Magri-M Solari-A, "The Sci Journal Citation Reports - A Potential Tool for Studying Journals .1. Description of the Jcr Journal Population-Based on the Number of Citations Received, Number of Source Items, Impact Factor, Immediacy Index and Cited Half-Life", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 93-117

Mahmoud-H Vongaza-H, "Development of Performance Indicators Using Vehicle and Crew Scheduling Data-Bases", LECTURE NOTES IN ECONOMICS AND MATHEMATICAL SYSTEMS,1992, Vol 386, pp 85-95

Mahoney-MJ, "Justice, Efficiency, and Epistemology in the Peer-Review of Scientific Manuscripts", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 157-157

Makovetskaya-O Bernadsky-V, "Scientometric Indicators for Identification of Technology System Life-Cycle Phase", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 105-116

Malevinskii-GV, "3 Features of Marketing of Scientific Production", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 2-INFORMATSIONNYE PROTSESSY I SISTEMY,1993, Iss 9, pp 6-7

Malik-DJ, "External Peer-Review of Course Content - A New Dimension Malo-S Rojo-L, "Stimuli for Scientific Productivity and Educational and Artistic Activities in Mexico", INTERCIENCIA 1996, Vol 21, Iss 2, pp 71+

Mallon-RD, "State-Owned Enterprise Reform Through Performance Contracts - The Bolivian Experiment", WORLD DEVELOPMENT,1994, Vol 22, Iss 6, pp 925-934

Manabe-S, "Modeling Study of Greenhouse Warming - A Citation-Classic Commentary on Thermal-Equilibrium of the Atmosphere with a Given Distribution of Relative-Humidity by Manabe,S. and Wetherald,R.T.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 38, pp 8-8

Mancini-G, "Refining the Angelotron - A Citation-Classic Commentary on Immunochemical Quantitation of Antigens by Single Radial Immunodiffusion by Mancini,G., Carbonara,A.O.,and Heremans,J.F.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 26, pp 9-9

Mann-D, "Serious Play", TEACHERS COLLEGE RECORD 1996, Vol 97, Iss 3, pp 446-469

Mann-L, "Protest Movements as a Source of Social-Change", AUSTRALIAN PSYCHOLOGIST,1993, Vol 28, Iss 2, pp 69-73

Mann-RW, "Problems with Peer-Review", TECHNOLOGY REVIEW,1992, Vol 95, Iss 2, pp 7-8

Manoharan-A, "Citations of Published Work", LANCET,1991, Vol 338, Iss 8758, pp 59-59

Mansfield-E, "The Diffusion of Industrial Innovations - A Citation-Classic Commentary on Technical Change and the Rate of Imitation by Mansfield,E.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 20, pp 8-8

Marezio-M, "The Ternary Molybdenum Sulfides - A Citation-Classic Commentary on Superconductivity of Ternary Sulfides and the Structure of PbMo6S8 by Marezio,M., Dernier,P.D., Remeika,J.P., Corenzwit,E., and Matthias,B.T.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 40, pp 9-9

Margulis-L, "The Inheritance of Acquired Microbes - A Citation-Classic Commentary on Symbiosis in Cell Evolution by

Margulis,L.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 16, pp 9-10

Mari-JD Streiner-DL, "An Overview of Family Interventions and Relapse on Schizophrenia - Metaanalysis of Research Findings", PSYCHOLOGICAL MEDICINE,1994, Vol 24, Iss 3, pp 565-578

Mariscal-AR, "Quantification of Information", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1993, Vol 18, Iss 3-4, pp 21-23

Markham-KM Mintzes-JJ Jones-MG, "The Concept Map as a Research and Evaluation Tool -Further Evidence of Validity", JOURNAL OF RESEARCH IN SCIENCE TEACHING,1994, Vol 31, Iss 1, pp 91-101

Markides-CC Williamson-PJ, "Related Diversification, Core Competences and Corporate Performance", STRATEGIC MANAGEMENT JOURNAL,1994, Vol 15, Iss NSI, pp 149-165

Markowitz-HM, "A Theory of Practice - A Citation-Classic Commentary on Portfolio Selection, Efficient Diversification of Investments by Markowitz,H.M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 36, pp 8-8

Marks-RJ, "The Journal Citation Report - Testifying for Neural Networks", IEEE TRANSACTIONS ON NEURAL NETWORKS 1996, Vol 7, Iss 4, pp 801-801

Markusova-V Gilyarevskii-R Chernyi-A Griffith-BC Garvey-WD, "Impacts of Perestroika and the Fsu Economic-Crisis upon Communication in Fsu Science - A Study of the Life Sciences (Reprinted from the Proceedings of the 5th Conference of the International Society for Scientometrics and Informetrics, June 1995)", PUBLISHING RESEARCH QUARTERLY 1996, Vol 12, Iss 1, pp 51-63

Markusova-VA, "Citation Index as the Means for Analysis of Scientific Publication Distribution by Languages", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 2-INFORMATSIONNYE PROTSESSY I SISTEMY,1992, Iss 12, pp 20-21

Markusova-VA Gilyarevskii-RS Chernyi-AI Griffith-BC, "Information Behavior of Russian Scientists in the Perestroika Period - Results of the Questionnaire Survey", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 361-380

Markusova-VA Griffith-BC, "Highly Cited Soviet Journals in the Physical and Life Sciences - A Study of the Function of Journals", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 99-113

Marmur-J, "Isolating DNA - A Citation-Classic Commentary on a Procedure for the Isolation of Deoxyribonucleic-Acid from Microorganisms by Marmur,J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 36, pp 9-10

Maroney-BP Buckely-MR, "Does Research in Performance-Appraisal Influence the Practice of Performance-Appraisal - Regretfully Not", PUBLIC PERSONNEL MANAGEMENT,1992, Vol 21, Iss 2, pp 185-196

Marsh-HW Ball-S, "Reflections on the Peer-Review Process", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 157-157

Marsh-JC, "Should Publication Productivity Be the Primary Criterion for Tenure Decisions - Response to Weick", JOURNAL OF SOCIAL WORK EDUCATION,1992, Vol 28, Iss 2, pp 138-139

Marshakovashaikevich-I, "The Standard Impact Factor as an Evaluation Tool of Science Fields and Scientific Journals", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 283-290

Marshakovashaikevich-IV, "Bibliometrics as a Research Technique in Epistemology and Philosophy of Science", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1993, Vol 18, Iss 3-4, pp 3-9

Marshall-E, "NIH Tunes Up Peer-Review", SCIENCE,1994, Vol 263, Iss 5151, pp 1212-1213

Marshall-E, "NIH Grants - Peer-Review Reforms Get Good Review", SCIENCE,1994, Vol 265, Iss 5171, pp 467-467

Marshall-E, "Peer-Review - Congress Finds Little Bias in System", SCIENCE,1994, Vol 265, Iss 5174, pp 863-863

Marshall-E, "Peer-Review - NIH Panel Urges Overhaul of the Rating System for Grants", SCIENCE 1996, Vol 272, Iss 5266, pp 1257-1257

Marshall-E, "Peer-Review - Despite Anxiety, NIH Begins Merging Neuroscience Panels", SCIENCE 1996, Vol 273, Iss 5276, pp 731-731

Marshall-E, "Trial Set to Focus on Peer-Review", SCIENCE 1996, Vol 273, Iss 5279, pp 1162-1164

Marshall-KC, "Adhesion of Marine-Bacteria - A Citation-Classic Commentary on Mechanism of the Initial Events in the Sorption of Marine-Bacteria to Surfaces by Marshall,K.C., Stout,R., and Mitchell,R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 2, pp 8-8

Marshall-KC, "Bacteria at Interfaces - A Citation-Classic Commentary on Interfaces in Microbial Ecology by Marshall,K.C.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 4, pp 8-8

Martell-RF Guzzo-RA Willis-CE, "A Methodological and Substantive Note on the Performance-Cue Effect in Ratings of Work-Group Behavior", JOURNAL OF APPLIED PSYCHOLOGY,1995, Vol 80, Iss 1, pp 191-195

Martello-A, "CitationRecords Reflect Broad Influence of NAS Members", SCIENTIST,1991, Vol 5, Iss 3, pp 16-

Martens-B Saretzki-T, "Conferences and Courses on Biotechnology - Describing Scientific Communication by Exploratory Methods", SCIENTOMETRICS,1993, Vol 27, Iss 3, pp 237-260

Martens-B Saretzki-T, "Quantitative-Analysis of Thematic Structures in the Field of Biotechnology - A Study on the Basis of Conference Data", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 117-128

Martin-B, "Peer-Review and the Origin of AIDS - A Case-Study in Rejected Ideas", BIOSCIENCE,1993, Vol 43, Iss 9, pp 624-627

Martin-BR, "Big History for Big Science - Critical-Review of History of CERN, by A. Hermann, J. Krige, U. Mersits, D. Pestre", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 371-371

Martin-BR, "British Science in the 1980s - Has the Relative Decline Continued", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 27-56

Martin-BR, "The Bibliometric Assessment of UK Scientific Performance - A Reply to Braun, Glanzel and Schubert", SCIENTOMETRICS,1991, Vol 20, Iss 2, pp 333-357

Martin-BR, "The Use of Multiple Indicators in the Assessment of Basic Research", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 343-362

Martin-M Humphries-B, "Representation and Difference in Cross-Cultural Research - The Impact of Institutional Structures", FEMINISM & PSYCHOLOGY 1996, Vol 6, Iss 2, pp 210-215

Martin-WJ Alston-JM, "A Dual Approach to Evaluating Research Benefits in the Presence of Trade Distortions", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1994, Vol 76, Iss 1, pp 26-35

Martocchio-JJ Webster-J Baker-CR, "Decision-Making in Management-Information-Systems Research - The Utility of Policy Capturing Methodology", BEHAVIOUR & INFORMATION TECHNOLOGY,1993, Vol 12, Iss 4, pp 238-248

Marton-F, "The Experimental Turn - A Citation-Classic Commentary on on Qualitative Differences in Learning .1. Outcome and Process .2. Outcome as a Function of Learners Conception of Task by Marton,F., and Saljo,R.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 34, pp 8-8

Maseri-A, "Coronary-Artery Spasm - A Citation-Classic Commentary on Variant Angina - One Aspect of a Continuous-Spectrum of Vasospastic Myocardial-Ischemia - Pathogenetic Mechanisms, Estimated Incidence and Clinical and Coronary Arteriographic Findings in 138 Patients, by Maseri,A., Severi,S., Denes,M., Labbate,A., Chierchia,S., Marzilli,M., Ballestrer,A.M., Parodi,O.,Biagini,A., Distante,A.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 38, pp 10-10

Masood-E, "Peer-Review Deemed Essential for Blue Skies Award Scheme", NATURE 1996, Vol 382, Iss 6591, pp 483-483

Massimo-L, "The Use of Indicators in the Research-and-Development Evaluation Activity of the European Communities", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 255-262

Masters-IM, "Citation Missed", CIM BULLETIN 1996, Vol 89, Iss 998, pp 8-8

Matherlee-KR, "The Outlook for Clinical Research - Impacts of Federal-Funding Restraint and Private-Sector Reconfiguration", ACADEMIC MEDICINE 1995, Vol 70, Iss 12, pp 1065-1072

Matricciani-E, "Shannons Entropy as a Measure of the Life of the Literature of a Discipline", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 129-145

Matson-JL Russell-D, "Development of the Psychopathology Instrument for Mentally-Retarded Adults Sexuality Scale (Pimra-S)", RESEARCH IN DEVELOPMENTAL DISABILITIES,1994, Vol 15, Iss 5, pp 355-369

Matthews-CH Moser-SB, "A Longitudinal Investigation of the Impact of Family Background and Gender on Interest in Small Firm Ownership", JOURNAL OF SMALL BUSINESS MANAGEMENT 1996, Vol 34, Iss 2, pp 29-43

Matthews-KA, "Understanding a Psychological Risk Factor for Coronary-Disease - A Citation-Classic Commentary on Psychological Perspectives on the Type-A Behavior Pattern by Matthews,K.A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 48, pp 8-8

Matthews-SA, "Using Citation Databases for Something Useful", AREA,1993, Vol 25, Iss 3, pp 309-313

Mattick-RP Darke-S, "Drug Replacement Treatments - Is Amphetamine Substitution a Horse of a Different Color", DRUG AND ALCOHOL REVIEW 1995, Vol 14, Iss 4, pp 389-394

Mattson-WJ, "Nitrogen - The Driving Element - A Citation-Classic Commentary on Herbivory in Relation to Plant Nitrogen-Content by

Mattson,W.J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 16, pp 8-8

Mattson-WJ, "Nitrogen - The Driving Element - A Citation-Classic Commentary on Herbivory in Relation to Plant Nitrogen-Content by Mattson,W.J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 16, pp 8-8

Mauguin-P, "Using a Contracts Database for Evaluating the Dynamics of a Technological Program - The Case of the EuropeanNonnuclear Energy Program", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 207-228

Mayer-DJ, "The Opiate of the Rats - A Citation-Classic Commentary on Analgesia from Electrical-Stimulation in the Brain-Stem of the Rat by Mayer,D.J., Wolfle,T.L., Akil,H., Carder,B., Liebeskind,J.C.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 14, pp 9-9

Mayer-DJ, "The Opiate of the Rats - A Citation-Classic Commentary on Analgesia from Electrical-Stimulation in the Brain-Stem of the Rat by Mayer,D.J., Wolfle,T.L., Akil,H., Carder,B., and Liebeskind,J.C.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 8, pp 8-8

Mcabee-GN, "Peer-Review of Medical Expert Witnesses", JOURNAL OF CHILD NEUROLOGY,1994, Vol 9, Iss 2, pp 216-217

Mcaleese-R, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 183-183

Mccabe-DL Dukerich-JM Dutton-JE, "The Effects of Professional-Education on Values and the Resolution of Ethical Dilemmas - Business School vs Law-School Students", JOURNAL OF BUSINESS ETHICS,1994, Vol 13, Iss 9, pp 693-700

Mccabe-RK Luzi-AD Brennan-T, "Managing Partners Perceptions of Peer-Review", AUDITING-A JOURNAL OF PRACTICE & THEORY,1993, Vol 12, Iss 2, pp 108-115

Mccahy-P, "Usefulness of Comments of Previous Peer Reviewers", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6958, pp 880-880

Mccain-KW, "Biotechnology in Context - A Database-Filtering Approach to Identifying Core and Productive Non-Core Journals Supporting Multidisciplinary Research-and-Development", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1995, Vol 46, Iss 4, pp 306-317

Mccain-KW, "Core Journal Networks and Cocitation Maps - New Bibliometric Tools for Serials Research and Management", LIBRARY QUARTERLY,1991, Vol 61, Iss 3, pp 311-336

Mccain-KW, "Core Journal Networks and Cocitation Maps in the Marine Sciences - Tools for Information Management in Interdisciplinary Research", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1992, Vol 29, pp 3-7

Mccain-KW, "Dictionary of Bibliometrics, by V. Diodato", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 9, pp 716-717

Mccain-KW, "International Librarianship - A Bibliometric Analysis of the Field, by N.J. Bliss", LIBRARY & INFORMATION SCIENCE RESEARCH,1994, Vol 16, Iss 2, pp 177-180

Mccain-KW, "Mapping of Science - Foci of Intellectual Interest in Scientific Literature, by R.R. Braam", LIBRARY QUARTERLY,1993, Vol

63, Iss 2, pp 230-231
Mccain-KW, "Mapping Economics Through the Journal Literature - An Experiment in Journal Cocitation Analysis", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 4, pp 290-296
Mccain-KW, "Some Determinants of Journal Holding Patterns in Academic-Libraries", LIBRARY & INFORMATION SCIENCE RESEARCH,1992, Vol 14, Iss 3, pp 223-243
Mccain-KW, "The Structure of Biotechnology Research-and-Development", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 153-175
Mccain-KW, "Visible Colleges - The Special Interest Group Co-Membership Structure of Asis", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 172-177
Mccain-KW Whitney-PJ, "Contrasting Assessments of Interdisciplinarity in Emerging Specialties - The Case of Neural Networks Research", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1994, Vol 15, Iss 3, pp 285-306
Mccarthy-J, "The State-of-the-Art of Cscw - Cscw Systems, Cooperative Work and Organization", JOURNAL OF INFORMATION TECHNOLOGY,1994, Vol 9, Iss 2, pp 73-83
Mccarthy-P, "Critics Sharpen Assault on Peer-Review - Some Even Recommend Abolishing the Traditional Process Used by Science Journal Editors to Evaluate Submitted Manuscripts", SCIENTIST,1994, Vol 8, Iss 11, pp 1+
Mccollum-JA Yates-TJ, "Technical Assistance for Meeting Early Intervention Personnel Standards - Statewide Processes", TOPICS IN EARLY CHILDHOOD SPECIAL EDUCATION,1994, Vol 14, Iss 3, pp 295-310
Mccord-JM, "A Radical Review of Ischemia - A Citation-Classic Commentary on Oxygen-Derived Free-Radicals in Postischemic Tissue-Injury by Mccord,J.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 50, pp 8-8
Mccord-JM, "A Radical Review of Ischemia - A Citation-Classic Commentary on Oxygen-Derived Free-Radicals in Postischemic Tissue-Injury by Mccord,J.M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 8, pp 8-8
Mccrory-DC Samsa-GP Weinberger-M Duncan-PW Matchar-DB, "Reliability of Reviewers with Different Backgrounds in Screening Citations from a Large Computer-Based Literature Search", CLINICAL RESEARCH,1993, Vol 41, Iss 2, pp A526-A526
Mccullough-J, "The Role and Influence of the United-States National-Science-Foundations Program Officers in Reviewing and Awarding Grants", HIGHER EDUCATION,1994, Vol 28, Iss 1, pp 85-94
Mccutchen-CW, "Peer-Review - Treacherous Servant, Disastrous Master", TECHNOLOGY REVIEW,1991, Vol 94, Iss 7, pp 28-
Mccutcheon-SC, "Status of Peer Reviews for the Journal-of-Environmental-Engineering", JOURNAL OF ENVIRONMENTAL ENGINEERING-ASCE,1993, Vol 119, Iss 6, pp 1002-1003
Mcdonell-JR, "Missing Citation", SOCIAL WORK,1993, Vol 38, Iss 6, pp 780-780
Mcdowall-J Allison-C, "Anxiety and Learning - A Dissociation Between Explicit and Implicit Processes", NEW ZEALAND JOURNAL OF

PSYCHOLOGY 1995, Vol 24, Iss 2, pp 44-50

Mcdowall-J Lustig-A Parkin-G, "Indirect Learning of Event Sequences - The Effects of Divided Attention and Stimulus Continuity", CANADIAN JOURNAL OF EXPERIMENTAL PSYCHOLOGY-REVUE CANADIENNE DE PSYCHOLOGIE EXPERIMENTALE 1995, Vol 49, Iss 4, pp 415-436

Mcfall-RM, "Development and Evaluation of an Interpersonal Skill-Training Program for Psychiatric-Inpatients - A Citation-Classic Commentary on Development and Evaluation of an Interpersonal Skill-Training Program for Psychiatric-Inpatients by Goldsmith,J.B., Mcfall,R.M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 46, pp 10-10

Mcgehee-CL, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1410-1410

Mcginnis-JM Foege-WH, "Actual Causes of Death in the United-States", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1993, Vol 270, Iss 18, pp 2207-2212

Mcgrath-WE, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 439-442

Mcgrath-WE, "The Unit of Analysis (Objects of Study) in Bibliometrics and Scientometrics", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 257-264

Mcgregor-GF, "Citation Analysis of Prior Art to Establish Novelty", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1992, Vol 203, Iss APR, pp 16-

Mchale-SM Crouter-AC Fennelly-K Tomascik-CA Updegraff-KA Graham-JE Baker-AE Dreisbach-L Ferry-N Manlove-EE Mcgroder-SM Mulkeen-P Obeidallah-DA, "Community-Based Interventions for Young Adolescents - The Penn-State Pride Project", JOURNAL OF RESEARCH ON ADOLESCENCE 1996, Vol 6, Iss 1, pp 23-36

Mckay-RT, "Citation of Drafts Questioned", AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL 1996, Vol 57, Iss 6, pp 576+

Mckenzie-D, "The Stretching Model for Sedimentary Basins - A Citation-Classic Commentary on Some Remarks on the Development of Sedimentary Basins by Mckenzie,D", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 8, pp 8-8

Mckenzie-R, "Diversity in Peer-Review", PHYSICAL THERAPY,1991, Vol 71, Iss 8, pp 624-624

Mckinlay-JB, "The Promotion of Health Through Planned Sociopolitical Change - Challenges for Research and Policy", SOCIAL SCIENCE & MEDICINE,1993, Vol 36, Iss 2, pp 109-117

Mclaren-MG, "Industry-University-Government Cooperative Research and Its Impact on Education", BRITISH CERAMIC TRANSACTIONS AND JOURNAL1990, Vol 89, Iss 6, pp 227-232

Mclellan-MF, "On the Importance of Inaccurate Bibliographic Citations - Reply", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 616-616

Mcleod-SD Gieser-JP, "Knowledge or Noise - Scientific Publication and the Electronic Journal", ARCHIVES OF OPHTHALMOLOGY 1996, Vol 114, Iss 10, pp 1269-1270

Mcnairn-WN, "Standards Overload and Peer-Review", JOURNAL OF ACCOUNTANCY,1991, Vol 171, Iss 3, pp 14

Mcneil-JG, "HIV-1 Vaccine Research and Evaluation in Thailand -

The Royal-Thai-Army United-States-Army HIV-1 Research Collaboration (Rta-USA HRC)", AIDS RESEARCH AND HUMAN RETROVIRUSES,1994, Vol 10, Iss S2, pp S247-S247

Meador-M Walters-SJK, "Unions and Productivity - Evidence from Academe", JOURNAL OF LABOR RESEARCH,1994, Vol 15, Iss 4, pp 373-386

Meadows-AJ, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 447-449

Meadows-AJ, "Quantitative Study of Factors Affecting the Selection and Presentation of Scientific Material to the General Public", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 113-119

Meehl-PE Yonce-LJ, "Taxometric Analysis .2. Detecting Taxonicity Using Covariance of 2 Quantitative Indicators in Successive Intervals of a 3rd Indicator (Maxcov Procedure)", PSYCHOLOGICAL REPORTS 1996, Vol 78, Iss 3, pp 1091-1227

Meezan-W, "Family Preservation Services - Research and Evaluation, by K. Wells, D.E. Biegel", SOCIAL SERVICE REVIEW,1993, Vol 67, Iss 1, pp 156-159

Meichtry-YJ, "The Impact of Science Curricula on Student Views Aboutthe Nature of Science", JOURNAL OF RESEARCH IN SCIENCE TEACHING,1993, Vol 30, Iss 5, pp 429-443

Meisels-A, "Human Papillomaviruses and Carcinoma of the Cervix - A Citation-Classic Commentary on Condylomatous Lesions of the Cervix and Vagina .1. Cytologic Patterns by Meisels,A. and Fortin,R. and Condylomatous Lesions of the Cervix .2. Cytologic, Colposcopic and Histopathologic Study by Meisels,A., Fortin,R., and Roy,M.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 28, pp 10-10

Melin-G, "The Networking University - A Study of a Swedish University Using Institutional Co-Authorships as an Indicator", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 15-31

Melin-G Persson-O, "Studying Research Collaboration Using Co-Authorships", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 363-377

Melland-HI, "Great Researcher ... Good Teacher", JOURNAL OF PROFESSIONAL NURSING 1996, Vol 12, Iss 1, pp 31-38

Mellander-S, "The Peripheral-Circulation - Organization and Regulation - A Citation-Classic Commentary on Control of Resistance, Exchange, and Capacitance Functions in the Peripheral-Circulation by Mellander,S., and Johansson,B.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 6, pp 10-10

Mendez-A, "Thinking About Scientometrics", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 393-395

Mendez-A Gomez-I, "Collaborative Research in Spain in the Field of Pharmacy and Pharmacology", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 137-147

Mendez-A Gomez-I Bordons-M, "Some Indicators for Assessing Research Performance Without Citations", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 157-167

Mendez-A Salvador-P, "The Application of Scientometric Indicators to the-Spanish-Scientific-Research-Council", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 61-78

Mendonca-CO Johnson-KE, "Peer-Review Negotiations - Revision Activities in ESL Writing Instruction", TESOL QUARTERLY,1994, Vol 28, Iss 4, pp 745-769

Meneghini-R, "Brazilian Production in Biochemistry - The Question ofInternational Versus Domestic Publication", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 21-30

Meneghini-R, "The Key Role of Collaborative Work in the Growth of Brazilian Science in the Last 10 Years", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 367-373

Meneses-R Valarino-E Yaber-G Simon-LP, "A Model for Analyzing Research Productivity in Counseling Psychology", INTERNATIONAL JOURNAL OF PSYCHOLOGY 1996, Vol 31, Iss 3-4, pp 54114-54114

Merriam-SB, "The Uses of Reminiscence in Older Adulthood", EDUCATIONAL GERONTOLOGY,1993, Vol 19, Iss 5, pp 441-450

Merril-CR, "Ultrasensitive Silver Stain for Proteins - A Citation-Classic Commentary on Ultrasensitive Stain for Proteins in Polyacrylamide Gels Shows Regional Variation in Cerebrospinal-Fluid Proteins by Merril,C.R., Goldman,D., Sedman,S.A., and Ebert,M.H.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 48, pp 9-9

Merton-RK, "Untitled", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp U3-U3

Mervis-J, "NIH Fine-Tunes Peer-Review to Clarify Long-Term Funding", SCIENTIST,1991, Vol 5, Iss 1, pp 6-

Mervis-J, "United-States-Army to Use Peer-Review in Breast-Cancer Program", NATURE,1993, Vol 363, Iss 6426, pp 195-195

Merz-RB Cimino-C Barnett-GO Blewett-DR Gnassi-JA Grundmeier-R Hassan-L, "A Pre-Search Estimation Algorithm for Medline Strategies with Qualifiers", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Iss S, pp 910-914

Messier-R, "Peer-Review or Performance Review", SCIENCE,1993, Vol 259, Iss 5091, pp 13-14

Messing-J, "From Too Trivial to a Classic - A Citation-Classic Commentary on a System for Shotgun DNA Sequencing by Messing,J., Crea,R. and Seeburg,P.H. and a New Pair of M13 Vectors for Selecting Either DNA Strand of Double Digest Restriction Fragments by Messing,J. and Vieira,J. and Improved M13 Phage Cloning Vectors and Host Strains -Nucleotide-Sequences of the M13Mp and Puc Vectors by Yanischperron,C., Vieira,J. and Messing,J.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 12, pp 11-12

Metoyerduran-C Hernon-P, "Economic-Development on American-Indian Reservations - A Citation Analysis", LIBRARY & INFORMATION SCIENCE RESEARCH,1995, Vol 17, Iss 1, pp 49-67

Metz-P, "Scholarly Communication and Bibliometrics, by C.L. Borgman", JOURNAL OF ACADEMIC LIBRARIANSHIP,1991, Vol 17, Iss 4, pp 232-232

Meybeck-M, "Rivers and Global Elemental Cycles - A Citation-Classic Commentary on Elemental Mass-Balance of Material Carried by Major World Rivers by Martin,J.M. and Meybeck,M.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 24, pp 10-10

Meyer-T Spencer-J, "A Citation Analysis Study of Library-Science - Who Cites Librarians", COLLEGE & RESEARCH LIBRARIES 1996, Vol 57, Iss 1, pp 23-33

Middleton-D Buchanan-K, "Is Reminiscence Working - Accounting for the Therapeutic Benefits of Reminiscence Work with Older-People",

JOURNAL OF AGING STUDIES,1993, Vol 7, Iss 3, pp 321-333
Midford-R, "Decriminalisation of Public Drunkenness in Western Australia - The Process Explained", AUSTRALIAN JOURNAL OF SOCIAL ISSUES,1993, Vol 28, Iss 1, pp 62-78
Milgram-NN, "Israel and the Gulf-War - The Major Events and Selected Studies", ANXIETY STRESS AND COPING,1994, Vol 7, Iss 3, pp 205-215
Miller-CA Richards-TB Christenson-GM Koch-GG, "Creating and Validating Practical Measures for Assessing Public-Health Practices in Local-Communities", AMERICAN JOURNAL OF PREVENTIVE MEDICINE 1995, Vol 11, Iss 6, pp 24-28
Miller-HI, "Increases in Research Productivity Are Not Rocket Science", SCIENTIST 1996, Vol 10, Iss 11, pp 10-10
Miller-HI, "Increases in Research Productivity Are Not Rocket Science", SCIENTIST 1996, Vol 10, Iss 11, pp 10-10
Miller-JM, "A Note on Citation Indexes", SCHOLARLY PUBLISHING,1991, Vol 22, Iss 4, pp 241-243
Miller-NE, "American Psychological-Association Citation for Outstanding Lifetime Contribution to Psychology - Presented to Miller,Neal,E., August 16, ,1991", AMERICAN PSYCHOLOGIST,1992, Vol 47, Iss 7, pp 847-847
Miller-R, "The Influence of Primary Task on Research-and-Development Laboratory Evaluation - A Comparative Bibliometric Analysis", R & D MANAGEMENT,1992, Vol 22, Iss 1, pp 3-20
Miller-R Manseau-A, "Bibliometric Indicators and the Competitive Environment of Research-and-Development Laboratories", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 421-433
Miller-RH, "From Warehouse to Gateway - A New University-Library and a New Paradigm", LIBRARY ACQUISITIONS-PRACTICE AND THEORY,1993, Vol 17, Iss 3, pp 319-331
Miller-RH Luft-HS, "Managed Care Plan Performance Since 1980 - A Literature Analysis", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 271, Iss 19, pp 1512-1519
Millon-T Davis-RD, "The Millon Adolescent Personality-Inventory and the Millon Adolescent Clinical Inventory", JOURNAL OF COUNSELING AND DEVELOPMENT,1993, Vol 71, Iss 5, pp 570-574
Milman-BL, "Individual Cocitation Clusters as Nuclei of Complete and Dynamic Informetric Models of Scientific and Technological Areas", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 45-57
Milman-BL Gavrilova-YA, "Analysis of Citation and Cocitation in Chemical-Engineering", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 53-74
Milman-BL Gavrilova-YA, "Clustering the Science-Citation-Index As the Method of Scientometric Analysis of General Chemical-Technology", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 1-ORGANIZATSIYA I METODIKA INFORMATSIONNOI RABOTY1990, Iss 12, pp 24-28
Milstead-JL, "Needs for Research in Indexing", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 8, pp 577-582
Milstein-C, "The 1st Useful Hybridoma - A Citation-Classic Commentary on Antibodies to Major Histocompatibility Antigens Produced by Hybrid Cell-Lines by Galfre,G., Howe,S.C., Milstein,C.,

Butcher,G.W., and Howard,J.C.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 40, pp 9-9

Milstein-C Brownlee-GG, "A Signal for Protein Secretion - A Citation-Classic Commentary on a Possible Precursor of Immunoglobulin Light-Chains by Milstein,C., Brownlee,G.G., Harrison,T.M., and Mathews,M.B.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 36, pp 8-8

Milstein-C Howard-JC, "The 1st Useful Hybridoma - A Citation-Classic Commentary on Antibodies to Major Histocompatibility Antigens Produced by Hybrid Cell-Lines by, Galfre,G., Howe,S.C., Milstein,C., Butcher,G.W., Howard,J.C.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 14, pp 8-8

Mimura-T, "Modulating 2-Dimensional Electron-Gas - A Citation-Classic Commentary on a New Field-Effect Transistor withSelectively Doped GaAs/N-AlxGa1-xAs Heterojunctions, by Mimura,T., Hiyamizu,S., Fujii,T., and Nanbu,K.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 28, pp 10-10

Miquel-JF, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 443-445

Miquel-JF Okubo-Y, "Structure of International Collaboration in Science .2. Comparisons of Profiles in Countries Using a Link Indicator", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 271-297

Mitchelldicenso-A Guyatt-G Marrin-M Goeree-R Willan-A Southwell-D Hewson-S Paes-B Rosenbaum-P Hunsberger-M Baumann-A, "A Controlled Trial of Nurse Practitioners in Neonatal Intensive-Care", PEDIATRICS 1996, Vol 98, Iss 6, pp 1143-1148

Mixon-FG, "What Can Regulators Regulate - The Case of the Urban Heat-Island Phenomenon", AMERICAN JOURNAL OF ECONOMICS AND SOCIOLOGY,1994, Vol 53, Iss 4, pp 403-414

Mizuhira-V, "Fixation Method for Proteins Using Tannic-Acid - A Citation-Classic Commentary on New Fixation Method for Biological-Membranes Using Tannic-Acid by Mizuhira,V., Futaesaku,Y.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 24, pp 9-9

Mock-NB Magnani-RJ Dikassa-L Rice-JC Abdoh-AA Bertrand-WE Mercer-DM, "The Utility of Case-Control Methods for Health-Policy and Planning Analysis - An Illustration from Kinshasa, Zaire", EVALUATION AND PROGRAM PLANNING,1993, Vol 16, Iss 3, pp 199-205

Moed-HF, "Differences in the Construction of Sci Based Bibliometric Indicators Among Various Producers - A First Overview", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 177-191

Moed-HF Debruin-RE Nederhof-AJ Tijssen-RJW, "International Scientific Cooperation and Awareness Within the European Community - Problems and Perspectives", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 291-311

Moed-HF Hesselink-FT, "The Publication Output and Impact of Academic Chemistry Research in the Netherlands During the 1980s - Bibliometric Analyses and Policy Implications", RESEARCH POLICY 1996, Vol 25, Iss 5, pp 819-836

Moed-HF Vanleeuwen-TN Reedijk-J, "A Critical Analysis of the Journal Impact Factors of Angewandte-Chemie and the Journal-of-the-American-Chemical-Society - Inaccuracies in Published Impact Factors Based on Overall Citations Only", SCIENTOMETRICS 1996,

Vol 37, Iss 1, pp 105-116

Mogee-ME Putnam-JD, "Patents Citation Analysis for Competitive Intelligence - Recent Explorations", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 43-CINF

Moleux-P, "Common OSHA Citations and a Brief OSHA Regulatory Update", PLATING AND SURFACE FINISHING,1994, Vol 81, Iss 3, pp 58-58

Mombour-W, "German Neo-Kraepelinians - A Citation-Classic Commentary on Procedure for Standardization of PsychopathologicalFindings by Mombour,W.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 24, pp 8-8

Moncada-S Palmer-RMJ, "Cellular Nitric-Oxide Synthesis - A Citation-Classic Commentary on Nitric-Oxide Release Accounts for the Biological-Activity of Endothelium-Derived Relaxing Factor by Palmer,R.M.J., Ferrige,A.G., and Moncada,S.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 4, pp 8-8

Mondal-MK Islam-MN Mowla-G Islam-MT Ghani-MA, "Impact of on-Farm Water Management Research on the Performance of a Gravity Irrigation System in Bangladesh", AGRICULTURAL WATER MANAGEMENT,1993, Vol 23, Iss 1, pp 11-22

Monnin-P Grosjean-F, "Characterizing and Predicting Performance Structures in French", ANNEE PSYCHOLOGIQUE,1993, Vol 93, Iss 1, pp 9-30

Monson-FC Wein-AJ Mckenna-BAW Whitmore-K Levin-RM, "Indigocarmine As a Quantitative Indicator of Urothelial Integrity", JOURNAL OF UROLOGY,1991, Vol 145, Iss 4, pp 842-845

Montgomery-D Bull-KS Baloche-L, "Characteristics of the Creative Person - Perceptions of University Teachers in Relation to the Professional Literature", AMERICAN BEHAVIORAL SCIENTIST,1993, Vol 37, Iss 1, pp 68-78

Moorbath-P, "A Study of Journals Needed to Support the Project-2000 Nursing Course with an Evaluation of Citation Counting as a Method of Journal Selection", ASLIB PROCEEDINGS,1993, Vol 45, Iss 2, pp 39-46

Moore-A Masterson-JT Christophel-DM Shea-KA, "College Teacher Immediacy and Student-Ratings of Instruction", COMMUNICATION EDUCATION 1996, Vol 45, Iss 1, pp 29-39

Moore-PD, "CitationRecords Indicate Leaders in Ecology Research (Reprinted from Science Watch, Vol 4, Pg 7-8, ,1993)", SCIENTIST,1994, Vol 8, Iss 3, pp 15-15

Moors-PJ, "Raou Fellow - Citation - Bell,Brian,Douglas", EMU1990, Vol 90, Iss DEC, pp 272-273

Moos-RH, "Stress and Coping Theory and Evaluation Research - An Integrated Perspective", EVALUATION REVIEW,1992, Vol 16, Iss 5, pp 534-553

Morales-ME Maliszewski-S Greenlees-M, "In Pursuit of Excellence - Quality Assurance, Documentation, and Peer-Review by Home Birth Cnms", JOURNAL OF NURSE-MIDWIFERY 1995, Vol 40, Iss 6, pp 555-569

Moran-G, "Ethical Questions About Peer-Review", JOURNAL OF MEDICAL ETHICS,1992, Vol 18, Iss 3, pp 160-160

Moran-G, "Guardians of Science - Fairness and Reliability of Peer-Review, by H.D. Daniel", LIBRARY & INFORMATION SCIENCE

RESEARCH,1995, Vol 17, Iss 1, pp 90-92
Morgan-M, "Peer-Review and Beasom Principle", WESTERN JOURNAL OF MEDICINE,1993, Vol 158, Iss 3, pp 309-310
Morgan-WJ, "Mortal Engines - The Science of Performance and the Dehumanization of Sport, by J.M. Hoberman", JOURNAL OF THE PHILOSOPHY OF SPORT,1992, Vol 19, pp 101-106
Moriearty-PL Shoubin-C, "International Access to the Chinese Medical Literature Through Medline", CHINESE MEDICAL JOURNAL,1993, Vol 106, Iss 4, pp 243-249
Morrill-TC, "Citation Counting", SCIENCE,1991, Vol 252, Iss 5013, pp 1599-1599
Morstyn-R, "Peer-Review of Psychotherapy", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY,1991, Vol 25, Iss 2, pp 152-
Morton-LP Lin-LY, "Content and Citation Analyses of Public-Relations Review", PUBLIC RELATIONS REVIEW 1995, Vol 21, Iss 4, pp 337-349
Mosnaim-AD Wolf-ME Curr-M Mosnaim-JN Freitag-FG Diamond-S, "Myths in Migraine Research .1. Migraine and Cluster Headache Patients Are Characterized by Significant Alterations in Platelet Monoamine-Oxidase Activity", HEADACHE QUARTERLY-CURRENT TREATMENT AND RESEARCH 1996, Vol 7, Iss 3, pp 225-234
Moss-G, "Time to Fight Peer-Review Abuse", AMERICAN JOURNAL OF SURGERY,1994, Vol 168, Iss 4, pp 365-365
Moynihan-JB Breathnach-CS, "A Survey of Manual Preference, Skill and Strength in Undergraduates", IRISH JOURNAL OF PSYCHOLOGICAL MEDICINE 1995, Vol 12, Iss 4, pp 127-131
Mozingo-D Ackley-GBE Bailey-JS, "Training Quality Job Interviews with Adults with Developmental-Disabilities", RESEARCH IN DEVELOPMENTAL DISABILITIES,1994, Vol 15, Iss 5, pp 389-410
Mulford-CL Waldnerhaugrud-L Gajbhiye-H, "Variables Associated with Agricultural Scientists Work Alienation and Publication Productivity", SCIENTOMETRICS,1993, Vol 27, Iss 3, pp 261-282
Muller-FA, "Aall Task-Force on Citation Formats Final Report - Dissenting Opinion", LAW LIBRARY JOURNAL 1995, Vol 87, Iss 3, pp 624-631
Mulligan-R Mackinnon-A Jorm-AF Giannakopoulos-P Michel-JP, "A Comparison of Alternative Methods of Screening for Dementia in Clinical Settings", ARCHIVES OF NEUROLOGY 1996, Vol 53, Iss 6, pp 532-536
Mullins-HE, "Citation of Drafts Questioned - Reply", AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL 1996, Vol 57, Iss 6, pp 578-580
Munkjorgensen-P, "Use of Registers in Psychiatric Research", NORDIC JOURNAL OF PSYCHIATRY 1996, Vol 50, Iss S37, pp 69-72
Murphy-LR, "Stress Management in Work Settings - A Critical-Review of the Health-Effects", AMERICAN JOURNAL OF HEALTH PROMOTION 1996, Vol 11, Iss 2, pp 112-135
Murphy-PA Albers-LL, "Evaluation of Research Studies .1. Randomized Trials", JOURNAL OF NURSE-MIDWIFERY,1992, Vol 37, Iss 4, pp 287-290
Murphy-PA Albers-LL, "Evaluation of Research Studies .2. Observational Studies", JOURNAL OF NURSE-MIDWIFERY,1992, Vol 37, Iss

6, pp 411-413
Murveeman-I Vanraak-A Maarse-H, "Dutch Home Care - Towards a New Organization", HEALTH POLICY,1994, Vol 27, Iss 2, pp 141-156
Musacchio-JM, "American Science in Crisis - The Need to Revise the NIH Funding Policy", FASEB JOURNAL,1994, Vol 8, Iss 10, pp 679-683
Mussurakis-S, "Do Citation Conventions Influence Coauthorship Patterns", AMERICAN JOURNAL OF ROENTGENOLOGY,1993, Vol 161, Iss 6, pp 1317-1319
Mydosh-JA, "The Spin-Glass Menagerie - A Citation-Classic Commentary on Spin-Glasses Recent Experiments and Systems by Mydosh,J.A.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 4, pp 8-8
Myers-BD, "Chronic Cyclosporine Nephrotoxicity - A Citation-Classic Commentary on Cyclosporine-Associated Chronic Nephropathy by Myers,B.D., Ross,J., Newton,L., Luetscher,J. and Perlroth,M.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 44, pp 8-8
Myers-SA Gleicher-N, "The Mount-Sinai Cesarean-Section Reduction Program - An Update After 6 Years", SOCIAL SCIENCE & MEDICINE,1993, Vol 37, Iss 10, pp 1219-1222
Nagpaul-PS, "Contribution of Indian Universities to the Mainstream Scientific Literature - A Bibliometric Assessment", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 11-36
Nagpaul-PS Pant-N, "Cross-National Assessment of Specialization Patterns in Chemistry", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 215-235
Nagpaul-PS Sharma-L, "Research Output and Transnational Cooperation in Physics Subfields - A Multidimensional-Analysis", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 97-122
Nahata-MC, "Research Productivity and Funding", DICP-THE ANNALS OF PHARMACOTHERAPY,1991, Vol 25, Iss 6, pp 669-670
Najarian-JS, "The Intent of Peer-Reviewed Journals - Reply", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 635-635
Nalimov-VV, "Meeting the Xxith Century", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 65-69
Nansen-P, "A Parasite Diagnosed by a Bacteriological Staining Method - A Citation-Classic Commentary on Staining of Cryptosporidia by a Modified Ziehl-Neelsen Technique by Henriksen,S.A., and Pohlenz,J.F.L.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 34, pp 10-10
Narin-F, "Globalization of Research, Scholarly Information, and Patents - 10 Year Trends", SERIALS LIBRARIAN,1991, Vol 21, Iss 2-3, pp 33-44
Narin-F, "Patent Citation Indicators", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 42-CINF
Narin-F, "Patent Bibliometrics", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 147-155
Narin-F, "Patents as Indicators for the Evaluation of Industrial-
Research Output", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 489-496
Narin-F Hamilton-KS, "Bibliometric Performance-Measures", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 293-310

Narin-F Olivastro-D, "Patent Citation Cycles", LIBRARY TRENDS,1993, Vol 41, Iss 4, pp 700-709

Narin-F Olivastro-D Stevens-KA, "Bibliometrics Theory, Practice and Problems", EVALUATION REVIEW,1994, Vol 18, Iss 1, pp 65-76

Narin-F Olivastro-D, "Status-Report - Linkage Between Technology and Science", RESEARCH POLICY,1992, Vol 21, Iss 3, pp 237-249

Narin-F Smith-VM Albert-MB, "What Patents Tell You About Your Competition", CHEMTECH,1993, Vol 23, Iss 2, pp 52-59

Narin-F Stevens-K Whitlow-ES, "Scientific Cooperation in Europe and the Citation of Multinationally Authored Papers", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 313-323

Narvaezberthelemot-N Deascencio-MA Russell-JM, "International Scientific Collaboration - Cooperation Between Latin-America and Spain, as Seen from Different Databases", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 5, pp 389-394

Narvaezberthelemot-N Frigoletto-LP Miquel-JF, "International Scientific Collaboration in Latin-America", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 373-392

Nash-DB Markson-LE Howell-S Hildreth-EA, "Evaluating the Competence of Physicians in Practice - From Peer-Review to Performance Assessment", ACADEMIC MEDICINE,1993, Vol 68, Iss 2, pp S19-S22

Nasir-AM Hassan-H Hamid-KA Agha-SS, "Bibliometric Evaluation of Agricultural Literature Published in Malaysia", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 191-217

Nath-D Sudharshan-D, "Measuring Strategy Coherence Through Patterns of Strategic Choices", STRATEGIC MANAGEMENT JOURNAL,1994, Vol 15, Iss 1, pp 43-61

Nath-LR Ross-S Smith-L, "A Case-Study of Implementing a Cooperative Learning-Program in an Inner-City School", JOURNAL OF EXPERIMENTAL EDUCATION 1996, Vol 64, Iss 2, pp 117-136

NATURE, "Peer-Review and the Courts", NATURE 1996, Vol 384, Iss 6604, pp 1-1

NATURE, Can Research Benefits Be Proved", NATURE,1992, Vol 359, Iss 6392, pp 173-174

NATURE, Citation Analysis - United-States Science OK", NATURE,1991, Vol 350, Iss 6313, pp 6-6

NATURE, Research to Benefit from Ex-Communist Funds", NATURE,1994, Vol 371, Iss 6493, pp 95-95

NATURE, Scientists Urge Peer-Review on Historians", NATURE,1994, Vol 369, Iss 6482, pp 594-594

NATURE, UK Council Backs Peer-Review Shift", NATURE,1994, Vol 369, Iss 6475, pp 3-4

NATURE, UK Research Council Splits Peer-Review from Policy Inputs", NATURE,1994, Vol 370, Iss 6484, pp 6-6

Natvig-JB, "Human Lymphocyte Identification - A Citation-Classic Commentary on Identification of 3 Different Human Lymphocyte Populations by Surface-Markers by Froland,S.S., Natvig,J.B.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 46, pp 8-8

Nauwelaers-C Reid-A, "Methodologies for the Evaluation of

Regional Innovation Potential", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 497-511

Nebert-DW, "Naming Related P450 Genes, Based on Divergent Evolution -A Citation-Classic Commentary on the P450 Gene Superfamily - Recommended Nomenclature by Nebert,D.W., Adesnik,M., Coon,M.J., Estabrook,R.W., Gonzalez,F.J., Guengerich,F.P., Gunsalus,I.C., Johnson,E.F., Kemper,B., Levin,W., Phillips,I.R., Sato,R., and Waterman,M.R.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 22, pp 9-10

Nederhof-AJ Meijer-RF, "Development of Bibliometric Indicators for Utility of Research to Users in Society - Measurement of External Knowledge Transfer via Publications in Trade Journals", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 37-48

Nederhof-AJ Meijer-RF Moed-HF Vanraan-AFJ, "Research Performance Indicators for University Departments - A Study of an Agricultural University", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 157-178

Nederhof-AJ Moed-HF, "Modeling Multinational Publication - Development of an Online Fractionation Approach to Measure National Scientific Output", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 39-52

Nederhof-AJ Noyons-ECM, "International Comparison of Departments Research Performance in the Humanities", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 3, pp 249-256

Nederhof-AJ Noyons-ECM, "Assessment of the International Standing of University Departments Research - A Comparison of Bibliometric Methods", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 393-404

Nederhof-AJ Vanraan-AFJ, "A Bibliometric Analysis of 6 Economics Research Groups - A Comparison with Peer-Review", RESEARCH POLICY,1993, Vol 22, Iss 4, pp 353-368

Nederhof-AJ Zwaan-RA, "Quality Judgments of Journals As Indicators of Research Performance in the Humanities and the Social and Behavioral-Sciences", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 5, pp 332-340

Nedeva-M Georghiou-L Loveridge-D Cameron-H, "The Use of Co-Nomination to Identify Expert Participants for Technology Foresight", R & D MANAGEMENT 1996, Vol 26, Iss 2, pp 155-168

Nedwek-BP Neal-JE, "Performance Indicators and Rational Management Tools - AComparative-Assessment of Projects in North-America and Europe", RESEARCH IN HIGHER EDUCATION,1994, Vol 35, Iss 1, pp 75-103

Neely-JG, "Literature-Review Articles as a Research Form", OTOLARYNGOLOGY-HEAD AND NECK SURGERY,1993, Vol 108, Iss 6, pp 743-748

Neely-JH, "Semantic Context and Word Recognition - A Citation-Classic Commentary on Semantic Priming and Retrieval from Lexical Memory - Evidence for Facilitatory and Inhibitory Processes and Semantic Priming and Retrieval from Lexical Memory - Roles of Inhibition Less Spreading Activation and Limited Capacity Attention by Neely,J.H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 20, pp 10-10

Neely-JH, "Semantic Context and Word Recognition - A Citation-Classic Commentary on Semantic Priming and Retrieval from Lexical Memory - Evidence for Facilitatory and Inhibitory Processes

and Semantic Priming and Retrieval from Lexical Memory - Roles of Inhibition Less Spreading Activation and Limited Capacity Attention by Neely,J.H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 20, pp 10-10

Negus-JA, "Peer-Review", NATURE,1992, Vol 358, Iss 6385, pp 364-364

Nelson-CR, "The 2-Charlies Paper - Is GNP a Random-Walk - A Citation-Classic Commentary on Trends and Random-Walks in Macroeconomic Time-Series by Nelson,C.R., and Plosser,C.I.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 28, pp 8-8

Nelson-DR Halperin-BI, "The Hexatic Phase of Matter - A Citation-Classic Commentary on Dislocation-Mediated Melting in 2Dimensions by Nelson,D.R. and Halperin,B.I.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 28, pp 9-9

Nelson-LD, "The Process of Peer-Review - Unanswered Questions", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 158-158

Nenner-RP, "Island Peer-Review Organization Educational Posters", NEW YORK STATE JOURNAL OF MEDICINE,1992, Vol 92, Iss 2, pp 57-58

Nettles-MT, "The Emerging National Policy Agenda on Higher-Education Assessment - A Wake-Up Call", REVIEW OF HIGHER EDUCATION,1995, Vol 18, Iss 3, pp 293-313

Neuman-AC, "Late-Onset Auditory Deprivation - A Review of Past Research and an Assessment of Future-Research", EAR AND HEARING 1996, Vol 17, Iss 3, pp S3-S13

Neumann-R, "Researching the Teaching-Research Nexus - A Critical-Review", AUSTRALIAN JOURNAL OF EDUCATION 1996, Vol 40, Iss 1, pp 5-18

Nevo-E, "Genetic Diversity Revisited - A Citation-Classic Commentary on Genetic-Variation in Natural-Populations Patterns and Theory by Nevo,E.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 4, pp 8-8

Nicholson-RS, "Congressional Pork Versus Peer-Review", SCIENCE,1992, Vol 256, Iss 5063, pp 1497-1497

Nicolini-C Vakula-S Balla-MI Gandini-E, "Can the Assignment of University Chairs Be Automated", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 93-107

Niemi-D, "A Fraction Is Not a Piece of Pie - Assessing Exceptional Performance and Deep Understanding in Elementary-School Mathematics", GIFTED CHILD QUARTERLY 1996, Vol 40, Iss 2, pp 70-80

Nieminen-P, "Type of Empirical-Research Reports, as an Explanatory Factor in Citation Performance of Psychiatric Research", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 309-320

Nikitenko-A, "The Family and Early-Childhood Center", RUSSIAN EDUCATION AND SOCIETY,1993, Vol 35, Iss 6, pp 79-93

Nishimura-LY Shane-RR Saltiel-E, "Prospective Physician Review of Orders for Colony-Stimulating Factors", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1992, Vol 49, Iss 11, pp 2722-2727

Nisonger-TE, "A Methodological Issue Concerning the Use of Social-Sciences Citation Index Journal Citation Reports Impact Factor Data for Journal Ranking", LIBRARY ACQUISITIONS-PRACTICE AND THEORY,1994, Vol 18, Iss 4, pp 447-458

Nisonger-TE, "The Relationship Between Price and Citation Data for Journals in 2 Subject Areas", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 151-159

Nissan-E Shimony-SE, "Tambalacoque - For a Formal Account of the Gist of a Scholarly Argument", KNOWLEDGE ORGANIZATION 1996, Vol 23, Iss 3, pp 135-146

Nissani-M, "The Plight of the Obscure Innovator in Science - A Few Reflections on Campanarios Note", SOCIAL STUDIES OF SCIENCE,1995, Vol 25, Iss 1, pp 165-183

Niwa-F Tomizawa-H, "A Trial of General Indicator of Science and Technology - Methodological Study of Overall Estimation of National S-and-T Activity", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 245-265

Nock-DA, "Star-Wars - Aspects of the Social Construction of Citations in Anglo-Canadian Sociology", CANADIAN REVIEW OF SOCIOLOGY AND ANTHROPOLOGY-REVUE CANADIENNE DE SOCIOLOGIE ET D ANTHROPOLOGIE,1992, Vol 29, Iss 3, pp 346-361

Nohr-C, "The Evaluation of Expert Diagnostic Systems - How to Assess Outcomes and Quality Parameters", ARTIFICIAL INTELLIGENCE IN MEDICINE,1994, Vol 6, Iss 2, pp 123-135

Nordhaus-WD, "Climate and Economic-Development - Climates Past and Climate-Change Future", WORLD BANK ECONOMIC REVIEW,1993, Iss S, pp 355-376

Nordling-C, "Making Electrons Talk - A Citation-Classic Commentary on Atomic, Molecular and Solid-State Structure Studied by Means of Electron-Spectroscopy by Siegbahn,K., Nordling,C., Fahlman,A., Hamrin,K., Hedman,J., Johansson,G., Bergmark,T., Karlsson,S.E., Lindgren,I., and Lindberg,B. and ESCA Applied to Free Molecules by Siegbahn,K., Nordling,C., Johansson,G., Hedman,J., Heden,P.F., Hamrin,K., Gelius,U., Bergmark,I., Werme,L.O., Manne,R., and Baer,Y.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 30, pp 10-10

Norman-GR Davis-DA Lamb-S Hanna-E Caulford-P Kaigas-T, "Competence Assessment of Primary-Care Physicians as Part of a Peer-Review Program", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1993, Vol 270, Iss 9, pp 1046-1051

Norman-GR Davis-DA Lamb-S Hanna-E Caulford-P Kaigas-T, "Competence Assessment of Primary-Care Physicians as Part of a Peer-Review Program (Vol 270, Pg 1046, ,1993)", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 271, Iss 2, pp 106-106

Norris-RP, "Authorship Patterns in Cjnr - 1970-,1991", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 151-158

North-ACT, "Easily Applied Absorption Corrections for Protein Crystals - A Citation-Classic Commentary on a Semiempirical Method of Absorption Correction by North,A.C.T., Phillips,D.C., and Mathews,F.S.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 32, pp 8-8

Norton-GW Pardey-PG Alston-JM, "Economic-Issues in Agricultural-Research Priority Setting", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 74, Iss 5, pp 1089-1094

Noser-TC Manakyan-H Tanner-JR, "Research Productivity and Perceived Teaching Effectiveness - A Survey of Economics Faculty", RESEARCH IN HIGHER EDUCATION 1996, Vol 37, Iss 3, pp 299-321

Nowicki-S, "Are We Lucky to Be Internal - A Citation-Classic Commentary on a Locus of Control Scale for Children by Nowicki,S. and Strickland,B.R.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 24, pp 10-10

Noyons-ECM Vanraan-AFJ, "Bibliometric Cartography of Scientific and Technological Developments of an Research-and-Development Field - The Case of Optomechatronics", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 157-173

Nuhfer-EB, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1409-1410

Nunn-GD Parish-TS, "An Attempt to Improve Perceptions of Educational-Evaluation Research", EDUCATION,1992, Vol 113, Iss 1, pp 91-92

Nutbeam-D Smith-C Murphy-S Catford-J, "Maintaining Evaluation Designs in Long-Term Community-Based Health Promotion Programs - Heartbeat Wales Case-Study", JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH,1993, Vol 47, Iss 2, pp 127-133

Nyatanga-L, "The Research Assessment Exercise (Rae) - Criteria and Issues", NURSE EDUCATION TODAY 1995, Vol 15, Iss 6, pp 395-396

Nylenna-M Riis-P Karlsson-Y, "Multiple Blinded Reviews of the 2 Manuscripts - Effects of Referee Characteristics and Publication Language", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 149-151

Oberhofer-CMA, "Information Use Value - A Test on the Perception of Utility and Validity", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 5, pp 587-600

Oberley-LW, "Superoxide-Dismutase and Cancer - A Citation-Classic Commentary on Role of Superoxide-Dismutase in Cancer - AReview by Oberley,L.W. and Buettner,G.R.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 24, pp 10-10

Obrien-M Dale-D, "Family-Centered Services in the Neonatal Intensive-Care Unit - A Review of Research", JOURNAL OF EARLY INTERVENTION,1994, Vol 18, Iss 1, pp 78-90

Obrien-PC, "Metaanalysis - Its Role in Medical-Research and in Assessment of the Association Between Low-Levels of Cholesterol and Excess Mortality", MAYO CLINIC PROCEEDINGS,1993, Vol 68, Iss 1, pp 91-93

Ockner-RK, "Fatty-Acid Binding-Proteins - Considerable Progress - More Ground to Cover - A Citation-Classic Commentary on a Binding-Protein for Fatty-Acids in Cytosol of Intestinal-Mucosa, Liver, Myocardium, and Other Tissues by Ockner,R.K., Manning,J.A., Poppenhausen,R.B., and Ho,W.K.L.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 40, pp 9-9

Oehmke-JF, "Optimal Evaluation of Research Portfolios", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS1990, Vol 72, Iss 5, pp 1374-1374

Offringa-G Dewet-G, "A Quality of Life-Based Decision-Support Model for the Determination of Water Research Priorities", WATER SA 1996, Vol 22, Iss 4, pp 359-372

Ogden-P, "Mastering the Lawless Science of Our Law - A Story of Legal Citation Indexes", LAW LIBRARY JOURNAL,1993, Vol 85, Iss 1, pp 1-48

Ogilvie-C, "Measurement of Gas Transfer in the Lung - A

Citation-Classic Commentary on a Standardized Breath Holding Technique for the Clinical Measurement of the Diffusing-Capacity of the Lung for Carbon-Monoxide by Ogilvie,C.M., Forster,R.E., Blakemore,W.S. and Morton,J.W.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 14, pp 10-10

Ogorman-JG, "Undergraduate Education in Psychology - Training the Practitioner as Well as the Scientist", AUSTRALIAN PSYCHOLOGIST,1993, Vol 28, Iss 1, pp 32-34

Ohara-MJ, "Volcanic Plumbing and Mantle Melting - A Cmas Hit - A Citation-Classic Commentary on the Bearing of Phase-Equilibria Studies in Synthetic and Natural Systems on the Origin and Evolution of Basic and Ultrabasic Rocks, by Ohara,M.J.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 30, pp 10-10

Oherlihy-J, "RT-and-D, Regional-Development and Evaluation", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 513-518

Okubo-Y, "Comments on Some of the Statements in the Article - The Measurement of International Scientific Collaboration by Luukkonen,T., Tijssen,R.J.W., Persson,O., Sivertsen,G.", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 37-39

Okubo-Y Miquel-JF Frigoletto-L Dore-JC, "Structure of International Collaboration in Science - Typology of Countries Through Multivariate Techniques Using a Link Indicator", SCIENTOMETRICS,1992, Vol 25, Iss 2, pp 321-351

Okuma-E, "Selecting Cd-ROM Databases for Nursing-Students - A Comparison of Medline and the Cumulative Index to Nursing and Allied Health Literature (Cinahl)", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1994, Vol 82, Iss 1, pp 25-29

Olah-GA, "Stable Carbocations - A Citation-Classic Commentary on Stable Carbonium-Ions .2. Oxocarbonium (Acylium) Tetrafluoroborates, Hexafluorophosphates, Hexafluoroantimonates and Hexafluoroarsenates - Structure and Chemical-Reactivity of Acyl Fluoride - Lewis Acid Fluoride Complexes by Olah,G.A., Kuhn,S.J., Tolgyesi,W.S. and Baker,E.B., Stable Carbonium-Ions .4. Secondary and Tertiary Alkyl and Aralkyl Oxocarbonium Hexafluoroantimonates - Formation and Identification of the Trimethylcarbonium Ion by Decarbonylation of the tert-Butyl Oxocarbonium Ion .5. Alkylcarbonium Hexafluoroantimonates by Olah,G.A., Baker,E.B., Evans,J.C., Tolgyesi,W.S., Mcintyre,J.S. and Bastien,I.J.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 24, pp 9-9

Oldham-RK, "Peer-Review", MOLECULAR BIOTHERAPY,1992, Vol 4, Iss 1, pp 2-3

Oleary-CJ, "Performance Indicators - A Management Tool for Active Labor Programs in Hungary and Poland", INTERNATIONAL LABOUR REVIEW 1995, Vol 134, Iss 6, pp 729-751

Oleary-KD, "Class Behavior - A Citation-Classic Commentary on a Token Reinforcement Program in a Public-School - A Replication and Systematic Analysis by Oleary,K.D., Becker,W.C., Evans,M.B., and Saudargas,R.A.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 40, pp 8-8

Oliker-SJ, "Does Workfare Work - Evaluation Research and Workfare Policy", SOCIAL PROBLEMS,1994, Vol 41, Iss 2, pp 195-213

Olmsted-WW, "Peer-Review of Radiographics Manuscripts - Is It Needed", RADIOGRAPHICS,1991, Vol 11, Iss 4, pp 529-530

Olsen-EJ, "Barringer-Medal Citation for Cassidy,William,A", METEORITICS & PLANETARY SCIENCE 1996, Vol 31, Iss 4, pp 431-432

Omalley-P Coventry-G Walters-R, "Victorias Day in Prison Program - An Evaluation and Critique", AUSTRALIAN AND NEW ZEALAND JOURNAL OF CRIMINOLOGY,1993, Vol 26, Iss 2, pp 171-183

Onions-K, "The Mantle Array - A Citation-Classic Commentary on Variations in Nd-143/Nd-144 and Sr-87/Sr-86 Ratios in Oceanic Basalts by Onions,R.K., Hamilton,P.J., and Evensen,N.M.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 14, pp 10-10

Onwude-JL Staines-A Lilford-RJ, "Multiple Author Trend Worst in Medicine", BRITISH MEDICAL JOURNAL,1993, Vol 306, Iss 6888, pp 1345-1345

Opie-I, "The Secret Lore of Childhood - A Citation-Classic Commentary on the Lore and Language of Schoolchildren by Opie,I. and Opie,P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 22, pp 10-10

Oppenheim-C, "The Correlation Between Citation Counts and the ,1992 Research Assessment Exercise Ratings for British-Library and Information-Science University Departments", JOURNAL OF DOCUMENTATION,1995, Vol 51, Iss 1, pp 18-27

Organ-CH, "The Intent of Peer-Reviewed Journals - Reply", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 634-635

Ortega-C Plaza-LM Martin-MJ Urdin-MC, "Spanish Scientific and Technical Journals - State-of-the-Art", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 21-42

Osgood-DW Smith-GL, "Applying Hierarchical Linear Modeling to Extended Longitudinal Evaluations - The Boys-Town Follow-Up-Study", EVALUATION REVIEW,1995, Vol 19, Iss 1, pp 3-38

Osterman-JW, "Should Cmaj Publish a French Edition", CANADIAN MEDICAL ASSOCIATION JOURNAL,1994, Vol 150, Iss 6, pp 861-866

Ottenbacher-KJ Hsu-YW Granger-CV Fiedler-RC, "The Reliability of the Functional Independence Measure - A Quantitative Review", ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION 1996, Vol 77, Iss 12, pp 1226-1232

Otto-RK Poythress-N Starr-L Darkes-J, "An Empirical-Study of the Reports of Apas Peer-Review Panel in the Congressional Review of the Uss Iowa Incident", JOURNAL OF PERSONALITY ASSESSMENT,1993, Vol 61, Iss 3, pp 425-442

Over-R, "Correlates of Career Advancement in Australian Universities", HIGHER EDUCATION,1993, Vol 26, Iss 3, pp 313-329

Overmann-RJ, "Peerless Science - Peer-Review and United-States Science Policy, by D.E. Chubin, E.J. Hackett", ISIS,1991, Vol 82, Iss 314, pp 711-712

PA-NG-MED-J, "Medlars Bibliography - Bibliographic Citation List Generated by the Australian-Medlars-Service", PAPUA NEW GUINEA MEDICAL JOURNAL,1993, Vol 36, Iss 1, pp 71-75

Paces-V Viklicky-V, "Peer-Review in the Czech Republic", SCIENCE,1993, Vol 262, Iss 5137, pp 1193-1193

Page-ME, "A Brief Citation Guide for Internet Sources in History

and the Humanities (Version 2.0)", PS-POLITICAL SCIENCE & POLITICS 1996, Vol 29, Iss 1, pp 83-84

Palincsar-AS, "A Retrospective View of Reciprocal Teaching - A Citation-Classic Commentary on Reciprocal Teaching of Comprehension-Fostering and Comprehension-Monitoring Activities by Palincsar,A.S., and Brown,A.L.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 36, pp 8-8

Palli-D Confortini-M Biggeri-A Russo-A Cariaggi-P Carozzi-F Minuti-PA, "A Quality-Control System Involving Peer-Review of Abnormal Cervical Smears", CYTOPATHOLOGY,1993, Vol 4, Iss 1, pp 17-25

Pandey-S Lindner-RK Medd-RW, "Towards an Economic Framework for Evaluating Potential Benefits from Research into Weed-Control", JOURNAL OF AGRICULTURAL ECONOMICS,1993, Vol 44, Iss 2, pp 322-344

Pandit-I, "Citation Errors in Library Literature - A Study of 5 Library-Science Journals", LIBRARY & INFORMATION SCIENCE RESEARCH,1993, Vol 15, Iss 2, pp 185-198

Pannell-JH, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1409-1409

Pao-ML, "Complementing Medline with Citation Searching", ACADEMIC MEDICINE,1992, Vol 67, Iss 8, pp 550-550

Pao-ML, "Correction", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 179-179

Pao-ML, "On the Relationship of Funding and Research Publications", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 257-281

Pao-ML, "Perusing the Literature via Citation Links", COMPUTERS AND BIOMEDICAL RESEARCH,1993, Vol 26, Iss 2, pp 143-156

Pao-ML, "Perusing the Literature via Citation Links (Vol 26, Pg 143, ,1993)", COMPUTERS AND BIOMEDICAL RESEARCH,1993, Vol 26, Iss 4, pp 413-413

Pao-ML, "Term and Citation Retrieval - A Field-Study", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 1, pp 95-112

Papadopoulos-S, "Evaluation of Industrial-Research", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 143-151

Pardeck-JT Chung-WS Murphy-JW, "An Examination of the Scholarly Productivity of Social-Work Journal Editorial-Board Members and Guest Reviewers", RESEARCH ON SOCIAL WORK PRACTICE,1995, Vol 5, Iss 2, pp 223-234

Pardee-AB, "A Growth-Control Event Defective in Tumors - A Citation-Classic Commentary on a Restriction Point for Control of Normal Animal-Cell Proliferation by Pardee,A.B.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 6, pp 11-11

Park-SH Gordon-ME, "Publication Records and Tenure Decisions in the Field of Strategic Management", STRATEGIC MANAGEMENT JOURNAL 1996, Vol 17, Iss 2, pp 109-128

Park-TK, "Survey of Electronic Journals in OCLC - The Extent and Quality of Cataloging", PROCEEDINGS OF THE ASIS ANNUAL MEETING 1996, Vol 33, pp 193-197

Park-TK, "The Nature of Relevance in Information-Retrieval - An Empirical-Study", LIBRARY QUARTERLY,1993, Vol 63, Iss 3, pp 318-351

Parker-G, "A Parental Bonding Instrument - A Citation-Classic Commentary on a Parental Bonding Instrument by Parker,G., Tupling,H.,

and Brown,L.B. and Parental Overprotection - A Risk Factor in Psychosocial Development by Parker,G.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 42, pp 10-10

Parker-M, "Bilharzia and the Boys - Questioning Common Assumptions", SOCIAL SCIENCE & MEDICINE,1993, Vol 37, Iss 4, pp 481-492

Parker-MT, "Formamide Extraction of Streptococci - What Is Left Behind - A Citation-Classic Commentary on the Formamide Method for the Extraction of Polysaccharides from Hemolytic Streptococci by Fuller,A.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 18, pp 11-11

Parker-PA Kulik-JA, "Burnout, Self-Rated and Supervisor-Rated Job-
Performance, and Absenteeism Among Nurses", JOURNAL OF BEHAVIORAL MEDICINE 1995, Vol 18, Iss 6, pp 581-599

Parodi-S Parodi-A Lombardo-C Santi-L, "Cancer-Research in the European-Community and Other Non-EC Countries", TUMORI,1993, Vol 79, Iss 1, pp 9-15

Parthey-H Schuetze-W, "Distribution of Publications As an Indicator for the Evaluation of Scientific Programs", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 459-464

Pasara-L, "The Role of Parliament - Argentina and Peru", DESARROLLO ECONOMICO-REVISTA DE CIENCIAS SOCIALES,1993, Vol 32, Iss 128, pp 603-624

Pate-JS, "Unraveling Plant Nitrogen-Metabolism - A Citation-Classic Commentary on Uptake, Assimilation and Transport of Nitrogen-Compounds by Plants by Pate,J.S.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 38, pp 10-10

Patel-P Pavitt-K, "The Continuing, Widespread (and Neglected) Importance of Improvements in Mechanical Technologies", RESEARCH POLICY,1994, Vol 23, Iss 5, pp 533-545

Patrick-WJ Stanley-EC, "Assessment of Research Quality", RESEARCH IN HIGHER EDUCATION 1996, Vol 37, Iss 1, pp 23-42

Patterson-DA, "An Electronic Social-Work Knowledge-Base - A Strategy for Global Information Sharing", INTERNATIONAL SOCIAL WORK 1996, Vol 39, Iss 2, pp 149+

Paulsen-JW, "The Bluebook - A Uniform System of Citation, by Columbia-Law-Review-Association", HARVARD LAW REVIEW,1992, Vol 105, Iss 7, pp 1780-1794

Pawelka-S Saradeth-T Ernst-E, "Scientific Productivity in Physical Medicine and Rehabilitation in Germany, Austria and Switzerland", ACTA MEDICA AUSTRIACA,1994, Vol 21, Iss 1, pp 11-13

Pawson-R Tilley-N, "What Works in Evaluation Research", BRITISH JOURNAL OF CRIMINOLOGY,1994, Vol 34, Iss 3, pp 291-306

Pawson-R Tilley-N, "Whats Crucial in Evaluation Research - A Reply", BRITISH JOURNAL OF CRIMINOLOGY 1996, Vol 36, Iss 4, pp 574-578

Pearlin-LI, "The Quotidian Character of Chronic Stress - A Citation-Classic Commentary on the Structure of Coping by Pearlin,L.I., and Schooler,C. and the Stress Process by Pearlin,L.I., Lieberman,M.A., Menaghan,E. and Mullan,J.T.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 30, pp 10-10

Pedigo-NW, "5Ht Binding Reveals New Receptors - A Citation-Classic Commentary on Discrimination of Multiple (H-5Ht)-H-3 Binding-Sites by the Neuroleptic Spiperone in Rat-Brain by Pedigo,N.W., Yamamura,H.I., and Nelson,D.L.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 26, pp 9-9

Peek-JM, "Detecting Habitat Preferences - A Citation-Classic Commentary on a Technique for Analysis of Utilization-Availability Data by Neu,C.W., Byers,C.R., Peek,J.M.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 22, pp 10-10

Pegg-DE, "Peer-Review Is OK", BRITISH MEDICAL JOURNAL,1991, Vol 302, Iss 6776, pp 596-596

Peissl-W, "Technology-Assessment in Austria - A Tentative Attempt", INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT 1996, Vol 11, Iss 5-6, pp 604-612

Penan-H, "R-and-D Strategy in a Technoeconomic Network - Alzheimers-Disease Therapeutic Strategies", RESEARCH POLICY 1996, Vol 25, Iss 3, pp 337-358

Pendlebury-D, ",1993 Nobel-Prizes Honor Basic Research-and-Development of Tools That Drive It - Rivals Share Laurels for Medicine, While Work on Pulsars and Gravitation Earns the Big Award in Physics", SCIENTIST,1993, Vol 7, Iss 23, pp 1+

Pendlebury-D, "Growth Has Peaked", NEW SCIENTIST,1992, Vol 136, Iss 1852-3, pp 75-75

Pendlebury-DA, "Citation Caution", CHEMISTRY & INDUSTRY,1993, Iss 15, pp 562-562

Pendlebury-DA, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1410-1411

Pendlebury-DA Anderson-A, "European Research Institutes - Response", SCIENCE,1992, Vol 258, Iss 5085, pp 1069-1070

Penny-AJ Appel-S Harley-K Muir-RK, "Collaborative Research in Education - Exploring an Epigenetic Landscape", STUDIES IN HIGHER EDUCATION,1994, Vol 19, Iss 1, pp 21-31

Perdew-JP, "Freshman Physics in Many-Body Theory - A Citation-Classic Commentary on Self-Interaction Correction to Density-Functional Approximations for Many-Electron Systems by Perdew,J.P., Zunger,A.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 30, pp 8-8

Perdew-JP Tipler-FJ, "Ranking the Physics Departments - Use Citation Analysis", PHYSICS TODAY 1996, Vol 49, Iss 10, pp 15+

Pereira-MEA, "Of Peanuts and Lectins - A Citation-Classic Commentary on Immunochemical Studies on the Specificity of Peanut (Arachis-Hypogaea) Agglutinin by Pereira,M.E.A., Kabat,E.A., Lotan,R., and Sharon,N.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 14, pp 8-8

Perezcuevas-R Guiscafre-H Munoz-O Reyes-H Tome-P Libreros-V Gutierrez-G, "Improving Physician Prescribing Patterns to Treat Rhinopharyngitis - Intervention Strategies in 2 Health Systems of Mexico", SOCIAL SCIENCE & MEDICINE 1996, Vol 42, Iss 8, pp 1185-1194

Peritz-BC, "Bibliometrics - An Annotated-Bibliography, 1970-1990, by M.K. Sellen", LIBRARY QUARTERLY,1994, Vol 64, Iss 3, pp

357-358

Peritz-BC, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 415-418

Peritz-BC, "On the Objectives of Citation Analysis - Problems of Theory and Method", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 6, pp 448-451

Peritz-BC, "On the Heuristic Value of Scientific Publications and Their Design - A Citation Analysis of Some Clinical-Trials", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 175-186

Peritz-BC, "On the Association Between Journal Circulation and Impact Factor", JOURNAL OF INFORMATION SCIENCE,1995, Vol 21, Iss 1, pp 63-67

Peritz-BC, "The Citation Impact of Letters to the Editor - The Case of Lancet", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 121-129

Perkins-DD Taylor-RB, "Ecological Assessments of Community Disorder - Their Relationship to Fear of Crime and Theoretical Implications", AMERICAN JOURNAL OF COMMUNITY PSYCHOLOGY 1996, Vol 24, Iss 1, pp 63-107

Perkins-DN Unger-C, "A New Look in Representations for Mathematics and Science Learning", INSTRUCTIONAL SCIENCE,1994, Vol 22, Iss 1, pp 1-37

Perkowitz-S, "Generating Science - Productivity and Policy", SCIENTIST,1993, Vol 7, Iss 2, pp 11-11

Perrault-AH, "The Shrinking National Collection - A Study of the Effects of the Diversion of Funds from Monographs to Serials on the Monograph Collections of Research-Libraries", LIBRARY ACQUISITIONS-PRACTICE AND THEORY,1994, Vol 18, Iss 1, pp 3-22

Perry-CA Rice-RE, "Scholarly Communication and Network Influences in the Hybrid Problem Area of Developmental Dyslexia", PROCEEDINGS OF THE ASIS ANNUAL MEETING 1996, Vol 33, pp 249-254

Perry-GM, "Exploring the Role of Mentoring in Agricultural-Economics PhD Training", JOURNAL OF AGRICULTURAL AND RESOURCE ECONOMICS 1996, Vol 21, Iss 1, pp 18-30

Perry-S Salisbury-L, "Access to Information in Both Citadel and Firstsearch - A Comparative-Study of Dissertation Coverage", INFORMATION TECHNOLOGY AND LIBRARIES,1995, Vol 14, Iss 1, pp 17-29

Persson-O, "The Intellectual Base and Research Fronts of Jasis 1986-1990", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 1, pp 31-38

Persson-O Melin-G, "Equalization, Growth and Integration of Science", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 153-157

Pestana-A, "Spanish Performance in Life Sciences - A Comparative Appraisal of the Scientific Production of Spain and 5 Other European Countries in 1989", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 95-114

Peters-A, "A Guide to the Cellular Structure of the Nervous-System -2 Citation-Classic Commentary on the Fine-Structure of the Nervous-System - The Neurons and Supporting Cells by Peters,A., Palay,S.L., and Webster,H.D.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 22, pp 9-9

Peters-CJ, "Citations and Areas of Research", FASEB JOURNAL,1991, Vol 5, Iss 10, pp 2488-2488

Peters-HPF Braam-RR Vanraan-AFJ, "Cognitive Resemblance and

Citation Relations in Chemical-Engineering Publications", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1995, Vol 46, Iss 1, pp 9-21

Peters-HPF Vanraan-AFJ, "Structuring Scientific Activities by Co-Author Analysis -An Exercise on a University-Faculty Level", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 235-255

Peters-HPF Vanraan-AFJ, "Co-Word-Based Science Maps of Chemical-Engineering .1. Representations by Direct Multidimensional-Scaling", RESEARCH POLICY,1993, Vol 22, Iss 1, pp 23-45

Peters-HPF Vanraan-AFJ, "Co-Word-Based Science Maps of Chemical-Engineering .2. Representations by Combined Clustering and Multidimensional-Scaling", RESEARCH POLICY,1993, Vol 22, Iss 1, pp 47-71

Peters-HPF Vanraan-AFJ, "A Bibliometric Profile of Top-Scientists - A Case-Study in Chemical-Engineering", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 115-136

Peters-HPF Vanraan-AFJ, "On Determinants of Citation Scores - A Case-Study in Chemical-Engineering", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 1, pp 39-49

Peters-JM, "Decision-Making, Cognitive Science and Accounting - An Overview of the Intersection", ACCOUNTING ORGANIZATIONS AND SOCIETY,1993, Vol 18, Iss 5, pp 383-405

Petersen-OH, "Calcium-Activated Ion Channels and Secretion - A Citation-Classic Commentary on Calcium-Activated Potassium Channels and Their Role in Secretion by Peterson,O.H., Maruyama,Y.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 48, pp 9-9

Petersen-RC Cummins-KW, "The Leaf-Stream Connection - A Citation-Classic Commentary on Leaf Processing in a Woodland Stream by Petersen,R.C. and Cummins,K.W.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 28, pp 10-10

Peterson-C, "Circumstance, Timing, and the Asq - A Citation-ClassicCommentary on the Attributional Style Questionnaire by Peterson,C., Semmel,A., Vonbaeyer,C., Abramson,L.Y., Metalsky,G.I., and Seligman,M.E.P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 22, pp 8-8

Peterson-C Seligman-MEP, "Methods, Fonts, and Explanatory Style - A Citation-Classic Commentary on Causal Explanations as a Risk Factor for Depression - Theory and Evidence by Peterson,C., Seligman,M.E.P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 32, pp 8-8

Pettigrew-KE Nicholls-PT, "Publication Patterns of LIS Faculty from 1982-,1992 - Effects of Doctoral Programs", LIBRARY & INFORMATION SCIENCE RESEARCH,1994, Vol 16, Iss 2, pp 139-156

Pfeffer-J, "Barriers to the Advance of Organizational Science - Paradigm Development as a Dependent Variable", ACADEMY OF MANAGEMENT REVIEW,1993, Vol 18, Iss 4, pp 599-620

Pfeffer-J Langton-N, "The Effect of Wage Dispersion on Satisfaction, Productivity, and Working Collaboratively - Evidence from College and University-Faculty", ADMINISTRATIVE SCIENCE QUARTERLY,1993, Vol 38, Iss 3, pp 382-407

PHARMACOPEIAL FORUM, USP Rationale for the Development of Public

Standards for Biological Products Licensed by the Food-and-Drug-Administrations Center for Biologics, Evaluation, and Research (FDA-Cber)", PHARMACOPEIAL FORUM,1992, Vol 18, Iss 4, pp 3754-3761

Phelan-M Wykes-T Goldman-H, "Global Function Scales", SOCIAL PSYCHIATRY AND PSYCHIATRIC EPIDEMIOLOGY,1994, Vol 29, Iss 5, pp 205-211

Philip-G, "Use of Leading-Edge Information-Systems by Academic Chemists in the UK .2. Constraints and the Need for Usability Engineering", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 2, pp 93-106

Philips-R, "Pseudometrics on Bibliographic Entities", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 193-199

Phillips-JC Russell-RK, "Research Self-Efficacy, the Research Training Environment, and Research Productivity Among Graduate-Students in Counseling Psychology", COUNSELING PSYCHOLOGIST,1994, Vol 22, Iss 4, pp 628-641

Phillis-JW, "Adenosine as a CNS Neurotransmitter - A Citation-Classic Commentary on the Role of Adenosine and Its Nucleotides in Central Synaptic Transmission by Phillis,J.W., and Wu,P.H.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 4, pp 9-9

Pichappan-P, "Identification of Mainstream Journals of Science Speciality - A Method Using the Discipline-Contribution Score", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 179-193

Pichappan-P, "Levels of Citation Relations Between Papers", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 8, pp 650-652

Pierce-AD, "Citation for Sparrow,Victor,W. - Indianapolis, Indiana - 15 May 1996", JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA 1996, Vol 99, Iss 4, pp U7-U8

Pierce-SJ, "On the Origin and Meaning of Bibliometric Indicators - Journals in the Social-Sciences, 1886-1985", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 7, pp 477-487

Pincus-HA Zarin-DA West-JC, "Peering into the Black-Box - Measuring Outcomes of Managed Care", ARCHIVES OF GENERAL PSYCHIATRY 1996, Vol 53, Iss 10, pp 870-877

Pinero-JML Terrada-ML, "Bibliometric Indicators and the Evaluation of the Medical-Scientific Activity .1. Use and Abuse of Bibliometry", MEDICINA CLINICA,1992, Vol 98, Iss 2, pp 64-68

Pinero-JML Terrada-ML, "Bibliometric Indicators and Evaluation of the Medical-Scientific Activity .2. Scientific Communication in the Different Areas of the Medical Sciences", MEDICINA CLINICA,1992, Vol 98, Iss 3, pp 101-106

Pinero-JML Terrada-ML, "Bibliometric Indicators and the Evaluation of the Medical-Scientific Activity .3. The Indicators of Production, Circulation and Dispersion, Consumption of the Information and Repercussion", MEDICINA CLINICA,1992, Vol 98, Iss 4, pp 142-148

Pinero-JML Terrada-ML, "The Consumption of National and Foreign Scientific-Information in Spanish Medical Journals - A New Repertory Study", MEDICINA CLINICA,1994, Vol 102, Iss 3, pp 104-112

Pinero-JML Terrada-ML, "Bibliometric Indicators and the Evaluation of Medical-Scientific Activity .4. The Application of the Indicators", MEDICINA CLINICA,1992, Vol 98, Iss 10, pp 384-388

Pines-A, "C-13 NMR in Solids - A Citation-Classic Commentary on Proton-Enhanced NMR of Dilute Spins in Solids by Pines,A., Gibby,M.G., and Waugh,J.S.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 32, pp 10-10

Pinto-A, "Supplementary Monograph-1, ,1993 - A Peer-Reviewed Monograph Based and Extended After the Workshop - 5-Aza-2'-Deoxycytidine and DNA Methyltransferase Inhibitors in the Treatment of Myeloid Leukemias and Myelodysplastic Syndromes - Biological Aspects and Clinical-Results, Presented at the 5th International-Symposium on Therapy of Acute Leukemias, Rome, Italy November 3, ,1991 - Foreword", LEUKEMIA,1993, Vol 7, Iss S1, pp U1-U1

Piotrowski-C, "A Review of the Clinical and Research Use of the Bender-Gestalt Test", PERCEPTUAL AND MOTOR SKILLS 1995, Vol 81, Iss 3, pp 1272-1274

Piotrowski-C, "The Status of Exner Comprehensive-System in Contemporary Research", PERCEPTUAL AND MOTOR SKILLS 1996, Vol 82, Iss 3, pp 1341-1342

Piotrowski-C Keller-JW, "The Rorschach and Shading - Citation Output from Psychological Abstracts (1987-,1992)", PSYCHOLOGICAL REPORTS,1993, Vol 72, Iss 2, pp 690-690

Piper-DL King-MJ Moberg-DP, "Implementing a Middle School-Health Promotion Research-Project - Lessons Our Textbook Didnt Teach Us", EVALUATION AND PROGRAM PLANNING,1993, Vol 16, Iss 3, pp 171-180

Piquer-CR, "Invited Speech", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 321-323

Pisani-BJ, "Support for Continuing the New-York-State Journal of Medicine as a Peer-Reviewed Clinical and Scientific Publication", NEW YORK STATE JOURNAL OF MEDICINE,1993, Vol 93, Iss 1, pp 63-63

Pitkin-RM, "The Peer-Review System", OBSTETRICS AND GYNECOLOGY,1993, Vol 82, Iss 2, pp 304-305

Pitot-HC Sirica-AE, "The Multistage Nature of Carcinogenesis - A Citation-Classic Commentary on the Stages of Initiation and Promotion in Hepatocarcinogenesis by Pitot,H.C., Sirica,A.E.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 16, pp 9-9

Platt-JJ Buhringer-G Widman-M Kunzel-J Lidz-V, "Uniform Standards for Substance User Treatment Research - An Example from Germany for the United-States and Other Countries", SUBSTANCE USE & MISUSE 1996, Vol 31, Iss 4, pp 479-492

Plaza-LM Martin-MJ Rey-J, "Scientific Relations Between Spain and Central-Eastern European Countries for the Period 1982-1992", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 131-142

Plomp-R, "The Highly Cited Papers of Professors as an Indicator of a Research Groups Scientific Performance", SCIENTOMETRICS,1994, Vol 29, Iss 3, pp 377-393

Plug-C, "The Reliability of Manuscript Evaluation for the South-African-Journal-of-Psychology", SOUTH AFRICAN JOURNAL OF PSYCHOLOGY-SUID-AFRIKAANSE TYDSKRIF VIR SIELKUNDE,1993, Vol 23, Iss 1, pp 43-48

Pockley-P, "Citation Score Boosts Australian Institute over Research Funds", NATURE 1996, Vol 382, Iss 6591, pp 484-484

Podolny-JM Stuart-TE, "A Role-Based Ecology of Technological-Change", AMERICAN JOURNAL OF SOCIOLOGY,1995, Vol 100, Iss 5, pp 1224-1260

Podolny-JM Stuart-TE Hannan-MT, "Networks, Knowledge, and Niches - Competition in the Worldwide Semiconductor Industry, 1984-1991", AMERICAN JOURNAL OF SOCIOLOGY 1996, Vol 102, Iss 3, pp 659-689

Polansky-NA, "A Historical-Perspective on Evaluation Research", RESEARCH ON SOCIAL WORK PRACTICE,1994, Vol 4, Iss 3, pp 389-398

Poling-A Alling-K Fuqua-RW, "Self-Citations and Cross-Citations in the Journal-of-Applied-Behavior-Analysis and the Journal-of-the-Experimental-Analysis-of-Behavior - 1983-,1992", JOURNAL OF APPLIED BEHAVIOR ANALYSIS,1994, Vol 27, Iss 4, pp 729-731

Polk-HC, "An Editors Perspective of the Future for Peer-Reviewed Traditional Surgical Journals", AMERICAN JOURNAL OF SURGERY,1991, Vol 161, Iss 2, pp 309-311

Polk-HC, "The Intent of Peer-Reviewed Journals - Reply", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 635-635

Poller-DN, "Promoting Research into Peer-Review - Identify Referees Institutions", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6953, pp 538-539

Pollin-IS, "Model Curriculum in Medical Crisis Counseling(Sm)", GENERAL HOSPITAL PSYCHIATRY,1992, Vol 14, Iss 6, pp S11-S27

Pollitt-C, "How Organizations Measure Success - The Use of Performance Indicators in Government, by N. Carter, R. Klein, P. Day", JOURNAL OF SOCIAL POLICY,1993, Vol 22, Iss APR, pp 271-272

Pond-K Ulhaq-R Wade-W, "Peer-Review - A Precursor to Peer Assessment", INNOVATIONS IN EDUCATION AND TRAINING INTERNATIONAL 1995, Vol 32, Iss 4, pp 314-323

Poole-M, "Reviewing for Research Excellence - Expectations, Procedures and Outcomes", AUSTRALIAN JOURNAL OF EDUCATION,1993, Vol 37, Iss 3, pp 219-230

POP-DEV-REV, "The Centers-for-Disease-Control and Prevention on Emerging Infectious-Disease Threats", POPULATION AND DEVELOPMENT REVIEW,1994, Vol 20, Iss 3, pp 687-690

POP-INDEX, "Citation of Working Papers in Population Index", POPULATION INDEX,1993, Vol 59, Iss 1, pp 3-4

POP-INDEX, "Language of Publication for Citations in Population-Index by Location of Author, ,1992-,1993", POPULATION INDEX,1994, Vol 60, Iss 2, pp 181-343

Porsolt-RD, "Behavioral Despair Revisited - A Citation-Classic Commentary on Depression - A New Animal-Model Sensitive to Antidepressant Treatments by Porsolt,R.D., Lepichon,M., and Jalfre,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 20, pp 9-9

Porter-AL Jin-XY Gilmour-JE Cunningham-S Xu-HD Stanard-C Wang-L, "Technology Opportunities Analysis - Integrating Technology Monitoring, Forecasting, and Assessment with Strategic-Planning", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS,1994, Vol 26, Iss 2, pp 21-31

Poser-CM, "Research in MS - A Citation-Classic Commentary on New

Diagnostic-Criteria for Multiple-Sclerosis - Guidelinesfor Research Protocols by Poser,C.M., Paty,D.W., Scheinberg,L., Mcdonald,W.I., Davis,F.A., Ebers,G.C., Johnson,K.P., Sibley,W.A., Silberberg,D.H., and Tourtellotte,W.W.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 4, pp 8-8

Posner-KL Caplan-RA Cheney-FW, "Variation in Expert Opinion in Medical Malpractice Review", ANESTHESIOLOGY 1996, Vol 85, Iss 5, pp 1049-1054

Posnett-NW, "Introduction of Performance Indicators at the Institute of Development Studies", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 5, pp 377-387

Pouris-A, "Economic Sanctions and Research-and-Development", SCIENTOMETRICS,1992, Vol 25, Iss 3, pp 415-424

Pouris-A, "Economies of Scale in Science and Technology Agencies", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 401-406

Pouris-A, "Identifying Areas of Strength in South-African Technology", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 23-35

Pouris-A, "Is Scientometrics in a Crisis", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 397-399

Pouris-A, "The Writing on the Wall of South-African Science - A Scientometric Assessment", SOUTH AFRICAN JOURNAL OF SCIENCE 1996, Vol 92, Iss 6, pp 267-271

Powe-NR Weiner-JP Starfield-B Stuart-M Baker-A Steinwachs-DM, "Systemwide Provider Performance in a Medicaid Program - Profiling the Care of Patients with Chronic Illnesses", MEDICAL CARE 1996, Vol 34, Iss 8, pp 798-810

Poythress-N Otto-RK Darkes-J Starr-L, "Apas Expert Panel in the Congressional Review of the Uss-Iowa Incident", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 1, pp 8-15

Prasad-AS, "A Diet of Zinc or Clay a Citation-Classic Commentary on Syndrome of Iron-Deficiency Anemia, Hepatosplenomegaly, Hypogonadism, Dwarfism, and Geophagia by Prasad,A.S., Halsted,J.A., Nadimi,M.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 28, pp 11-11

Prasad-AS, "Deficiencies of Iron and Zinc - A Citation-Classic Commentary on Biochemical-Studies on Dwarfism, Hypogonadism, and Anemia by Prasad,A.S., Miale,A., Farid,Z., Sandstead,H.H., Schulert,A.R., and Darby,W.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 44, pp 10-10

Pravdic-N Oluicvukovic-V, "Distribution of Scientific Productivity - Ambiguities in the Assignment of Author Rank", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 131-144

Pray-CE, "The Impact of Privatizing Agricultural-Research in Great-
Britain - An Interim-Report on PBI and Adas", FOOD POLICY 1996, Vol 21, Iss 3, pp 305-318

Propper-IMAM, "Sound Arguments and Power in Evaluation Research and Policy-Making - A Measuring Instrument and Its Application", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1993, Vol 15, Iss 1, pp 78-105

Provost-F Nieuwenhuysen-P, "Measuring Overlap of Data-Bases in Water-Supply and Sanitation Using Sampling and the Binomial Probability-Distribution", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp

201-209
Prpic-K, "Characteristics and Determinants of Eminent Scientists Productivity", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp.185-206
Prpic-K, "The Sociocognitive Frameworks of Scientific Productivity", SCIENTOMETRICS,1994, Vol 31, Iss 3, pp 293-311
Pruthi-S Jain-A Wahid-A Nabi-SA, "Problems of Management of Scientific-Research - Results of a Survey", JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH,1993, Vol 52, Iss 2, pp 81-94
Pryor-WA, "Mechanisms of Free-Radical Reactions - A Citation-Classic Commentary on Free-Radicals by Pryor,W.A.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 24, pp 10-10
Pudovkin-AI, "Citation Relationships Among Marine Biology Journals and Those in Related Fields", MARINE ECOLOGY-PROGRESS SERIES,1993, Vol 100, Iss 1-2, pp 207-209
Pulido-M Gonzalez-JC Sanz-F, "Errors in Bibliographic References - A Retrospective Study in Medicina-Clinica (1962-,1992)", MEDICINA CLINICA,1995, Vol 104, Iss 5, pp 170-174
Purves-AC, "Reflections on Research and Assessment in Written Composition", RESEARCH IN THE TEACHING OF ENGLISH,1992, Vol 26, Iss 1, pp 108-122
Putterman-C, "Quotation Accuracy - Fact or Fiction", ISRAEL JOURNAL OF MEDICAL SCIENCES,1992, Vol 28, Iss 7, pp 465-470
Pyle-R Mitchell-J Eckert-E, "An Early Clinical Description of Bulimia - A Citation-Classic Commentary on Bulimia - A Report of 34 Cases by Pyle,R.L., Mitchell,J.E., and Eckert,E.D.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 4, pp 8-8
Qin-J, "An Investigation of Research Collaboration in the Sciences Through the Philosophical-Transactions 1901-,1991", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 219-238
Quill-J, "Using Consultants in Evaluation Research - A Clients Perspective", EVALUATION AND PROGRAM PLANNING,1992, Vol 15, Iss 1, pp 67-69
Quinnan-GV, "Fdas Center for Biologics Evaluation and Research Comments on the Report of the Expert Panel", PUBLIC HEALTH REPORTS,1991, Vol 106, Iss 1, pp 31-31
Quoniam-L Dou-H Hassanaly-P Mille-G, "Bibliometrics and Chemistry - An Example on Fatty-Acids and Phospholipides", ANALUSIS,1991, Vol 19, Iss 1, pp I48-I52
Qurashi-MM, "Dependence of Publication-Rate on Size of Some University Groups and Departments in UK and Greece in Comparison with NCI, USA", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 19-38
Qurashi-MM, "Publication-Rate and Size of Two Prolific Research Groups in Departments of Inorganic-Chemistry at Dacca University (1944-1965) and Zoology at Karachi University (1966-84)", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 79-92
Raber-LR, "NIH Contemplates Changes in Its Peer-Review Process, Worrying Researchers", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 28, pp 23-24
Rabin-C Savaya-R Frank-P, "A Joint University Field Agency - Toward the Integration of Classroom and Practicum", JOURNAL OF SOCIAL WORK EDUCATION,1994, Vol 30, Iss 1, pp 107-115

Rabinovich-JE, "Publications of Scientists of Developing-Countries in International Journals - Are They Channels to the International Circuit for Colleagues That Only Publish in National Journals - A Case-Study from the Field of Ecology in Argentina", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 91-103

Rabinowitz-H, "The Developers Vernacular - The Owners Influence on Building Design", JOURNAL OF ARCHITECTURAL AND PLANNING RESEARCH 1996, Vol 13, Iss 1, pp 34-42

Rabinowitz-WM Eddington-DK, "Myths, Citations, and Single-Channel Implants - A Reply", EAR AND HEARING 1996, Vol 17, Iss 3, pp 277-279

Rabkin-YM Mirskaya-EZ, "Science and Scientists in the Post-Soviet Disunion", SOCIAL SCIENCE INFORMATION SUR LES SCIENCES SOCIALES,1993, Vol 32, Iss 4, pp 553-579

Race-KEH Silverberg-JA, "Toward a Reliable Measure of Breast Self-Examination - Attitudes and Performance Barriers", EVALUATION REVIEW 1996, Vol 20, Iss 5, pp 541-551

Rachal-JR Hemby-KV Grubb-RE, "Institutional Publication Productivity in Selected Gerontology Journals, 1984-1993", EDUCATIONAL GERONTOLOGY 1996, Vol 22, Iss 3, pp 281-291

Rachal-JR Sargent-SF, "Publication Productivity of North-American Institutions in Selected Adult-Education Journals, 1983-,1992", ADULT EDUCATION QUARTERLY,1995, Vol 45, Iss 2, pp 63-78

Radhakrishnan-P Arrow-H Sniezek-JA, "Hoping, Performing, Learning, and Predicting - Changes in the Accuracy of Self-Evaluations of Performance", HUMAN PERFORMANCE 1996, Vol 9, Iss 1, pp 23-49

Raghuram-N Madhavi-Y, "India Declining Ranking", NATURE 1996, Vol 383, Iss 6601, pp 572-572

Raghuram-N Madhavi-Y, "India Declining Ranking", NATURE 1996, Vol 383, Iss 6601, pp 572-572

Rainville-EC Possidente-CJ Harry-DJ, "A Peer Review-Based Quality Assurance System", AMERICAN JOURNAL OF HOSPITAL PHARMACY,1991, Vol 48, Iss 7, pp 1531-1533

Raj-CBC, "Publications, Cost and a Proposition", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 87-103

Rajeswari-AR, "Indian Patents Statistics - An Analysis", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 109-130

Rakic-P, "Competitive Interactions in Genesis of Connections - A Citation-Classic Commentary on Prenatal Genesis of Connections Subserving Ocular Dominance in the Rhesus-Monkey by Rakic,P. and Prenatal Development of the Visual-System in Rhesus-Monkey by Rakic,P.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 4, pp 9-9

Ramsay-AD Gallagher-PJ, "Local Audit of Surgical Pathology - 18 Months Experience of Peer-Review Based Quality Assessment in an English Teaching Hospital", AMERICAN JOURNAL OF SURGICAL PATHOLOGY,1992, Vol 16, Iss 5, pp 476-482

Ramsay-ML Lehto-H, "The Power of Peer-Review", TRAINING & DEVELOPMENT,1994, Vol 48, Iss 7, pp 38-41

Ramsden-P, "A Performance Indicator of Teaching Quality in Higher-Education - The Course Experience Questionnaire", STUDIES IN HIGHER EDUCATION,1991, Vol 16, Iss 2, pp 129-150

Ramsden-P, "Describing and Explaining Research Productivity", HIGHER EDUCATION,1994, Vol 28, Iss 2, pp 207-226
Rangachari-PK, "Interpreting Citations", FASEB JOURNAL,1991, Vol 5, Iss 11, pp 2612-2612
Ransdell-S, "Educational Software-Evaluation Research - Balancing Internal, External, and Ecological Validity", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS,1993, Vol 25, Iss 2, pp 228-232
Ranz-WE, "Rate-Processes at a Spherical Boundary - A Citation-Classic Commentary on Evaporation from Drops .1.2. by Ranz,We, Marshall,WR", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 22, pp 8-8
Rao-IKR, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 465-469
Rao-IKR, "Methodological and Conceptual Questions of Bibliometric Standards", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 265-270
Rapaport-FT, "Dedication of the 14th International-Congress of the Transplantation Society - The Hamburger,Jean Memorial Congress - And Citations", TRANSPLANTATION PROCEEDINGS,1993, Vol 25, Iss 1, pp 4-6
Rashid-HF, "Bibliometric Analysis As a Tool in Journal Evaluation", SERIALS LIBRARIAN,1991, Vol 20, Iss 2-3, pp 55-64
Raub-WF, "Age-Discrimination in NIH Peer-Review", FASEB JOURNAL,1991, Vol 5, Iss 1, pp 116-116
Ravnskov-U, "Cholesterol Lowering Trials in Coronary Heart-Disease - Frequency of Citation and Outcome", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6844, pp 15-19
Ravnskov-U, "Frequency of Citation and Outcome of Cholesterol Lowering Trials - Reply", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 422-422
Ravnskov-U, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6855, pp 717-717
Rawling-A, "The AIDS Virus Dispute - Awarding Priority for theDiscovery of the Human-Immunodeficiency-Virus (HIV)", SCIENCE TECHNOLOGY & HUMAN VALUES,1994, Vol 19, Iss 3, pp 342-360
Raykova-DD, "Socio-Bibliometric Analysis of Sociological Studies", SOTSIOLOGICHESKIE ISSLEDOVANIYA,1991, Iss 1, pp 74-81
Raymond-RD Sesnowitz-ML Williams-DR, "Further Evidence on Gender and Academic Rank", QUARTERLY REVIEW OF ECONOMICS AND FINANCE,1993, Vol 33, Iss 2, pp 197-215
Read - Acid-Reducing Surgery in, Aggressive Resection Out", AMERICAN JOURNAL OF GASTROENTEROLOGY 1996, Vol 91, Iss 6, pp 1067-1070
Redfern-SAT, "Promoting Research into Peer-Review - No Quick Fixes", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6953, pp 538-538
Redionov-D Babic-K Nikolic-V, "Research on the Impact of the Functional and Genetic-Factors on Growth and Development of the Orofacial Complex", JOURNAL OF DENTAL RESEARCH 1996, Vol 75, Iss 5, pp 1231-1231
Reed-GL, "Column Should Provide Citations", CIVIL

ENGINEERING,1993, Vol 63, Iss 11, pp 35-35

Reedijk-J, "Citation Confusion", CHEMISTRY & INDUSTRY,1993, Iss 18, pp 690+

Rees-DA, "Linkage Rotation - Testing a Formula - A Citation-Classic Commentary on Conformational-Analysis of Polysaccharides .5. Characterization of Linkage Conformations (Chain Conformations) by Optical-Rotation at a Single Wavelength - Evidence for Distortion of Cyclohexa-Amylose in Aqueous-Solution - Optical-Rotation and the Amylose Conformation by Rees,D.A. and Polysaccharide Conformation .6. Computer Model-Building for Linear and Branched Pyranoglycans - Preliminary Assessment of Inter-Residue Forces in Aqueous-Solution - Further Interpretation of Optical-Rotation in Terms of Chain Conformation by Rees,D.A. and Scott,W.E.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 32, pp 9-9

Rees-DA, "Medical-Research-Council Defends Peer-Review", BRITISH MEDICAL JOURNAL,1993, Vol 306, Iss 6894, pp 1757-1757

Reese-LA Fasenfest-D, "More of the Same - A Research Note on Local Economic-Development Policies over Time", ECONOMIC DEVELOPMENT QUARTERLY 1996, Vol 10, Iss 3, pp 280-289

Refinetti-R, "Low Citation Rates - Who Is to Blame", FASEB JOURNAL,1991, Vol 5, Iss 8, pp 2217-2217

Reguant-S Casadella-J, "English as Lingua-Franca in Geological Scientific Publications - A Bibliometric Analysis", SCIENTOMETRICS,1994, Vol 29, Iss 3, pp 335-351

Reichert-C, "Labor Migration and Rural-Development in Egypt - A Study of Return Migration in 6 Villages", SOCIOLOGIA RURALIS,1993, Vol 33, Iss 1, pp 42-60

Reid-JJ, "Peer-Review at American Antiquity", AMERICAN ANTIQUITY1990, Vol 55, Iss 4, pp 665-666

Reidenberg-JW Reidenberg-MM, "Report of a Survey of Some Aspects of Editorial-Board Peer-Review at Clinical-Pharmacology-and-Therapeutics", CLINICAL PHARMACOLOGY AND THERAPEUTICS,1991, Vol 50, Iss 1, pp 1-3

Reinsch-NL Reinsch-JW, "Some Assessments of Business Communication Scholarship from Social-Science Citations", JOURNAL OF BUSINESS AND TECHNICAL COMMUNICATION 1996, Vol 10, Iss 1, pp 28-47

Reiser-LW Sledge-WH Fenton-W Leaf-P, "Beginning Careers in Academic Psychiatry for Women - Bermuda Triangle", AMERICAN JOURNAL OF PSYCHIATRY,1993, Vol 150, Iss 9, pp 1392-1397

Reiter-L, "Scientific Status as Dynamic System - Bibliometric Study on 3 Systems Journals", SYSTEM FAMILIE-FORSCHUNG UND THERAPIE,1993, Vol 6, Iss 4, pp 246-249

Rekker-RF, "The Hydrophobic Fragmental Constant - A Citation-Classic Commentary on the Hydrophobic Fragmental Constant - Its Derivation and Application with a Means of Characterizing Membrane Systems by Rekker,R.F.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 20, pp 8-8

Renia-H, "Science Under Scarcity - Principles and Practice for Agricultural-Research Evaluation and Priority Setting, by J.M. Alston, G.W. Norton, P.G. Pardey", JOURNAL OF AGRICULTURAL ECONOMICS 1996, Vol 47, Iss 2, pp 271-272

Rennie-D, "More Peering into Editorial Peer-Review", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1993, Vol 270, Iss 23, pp 2856-2858

Rennie-D, "Suspended Judgment - Editorial Peer-Review - Let Us Put It on Trial", CONTROLLED CLINICAL TRIALS,1992, Vol 13, Iss 6, pp 443-445

Rennie-D Flanagin-A, "The 2nd International-Congress on Peer-Review in Biomedical Publication", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 91-91

Renzulli-JS Reis-SM, "Research Related to the Schoolwide Enrichment Triad Model", GIFTED CHILD QUARTERLY,1994, Vol 38, Iss 1, pp 7-20

RES-TECH-M, "Evaluating Research-and-Development Impacts - Methods and Practice, by B. Bozeman, J. Melkers", RESEARCH-TECHNOLOGY MANAGEMENT,1994, Vol 37, Iss 1, pp 61-61

RES-TECH-M, "Research Impact Assessment", RESEARCH-TECHNOLOGY MANAGEMENT,1994, Vol 37, Iss 1, pp 63-63

Restivo-S, "Citation for Barber,Bernard, 1995-Bernal-Prize Recipient", SCIENCE TECHNOLOGY & HUMAN VALUES 1996, Vol 21, Iss 3, pp 340-341

Retzlaff-WA Williams-LE Dejong-TM, "Photosynthesis, Growth, and Yield Response of Casselman Plum to Various Ozone Partial Pressures During Orchard Establishment", JOURNAL OF THE AMERICAN SOCIETY FOR HORTICULTURAL SCIENCE,1992, Vol 117, Iss 5, pp 703-710

Reuben-DB, "The Journals Peer-Review Process - A 2-Way Street", JOURNAL OF THE AMERICAN GERIATRICS SOCIETY,1992, Vol 40, Iss 10, pp 1072-1074

Reuben-RC, "New Cites for Sore Eyes - A 2nd Federal Appeals Court Allows Citation of Unpublished Opinions", ABA JOURNAL,1994, Vol 80, Iss JUN, pp 22-22

Reyniers-P, "Facts and Figures on Interlibrary Lending in Dutch-Speaking Belgium in 1989", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 59-76

Rhoads-DC, "Defining the Scope of an Emerging Field - A Citation-Classic Commentary on Organism-Sediment Relationships on the Muddy Sea-Floor by Rhoads,D.C.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 30, pp 10-10

Riccio-JA Orenstein-A, "Understanding Best Practices for Operating Welfare-to-Work Programs", EVALUATION REVIEW 1996, Vol 20, Iss 1, pp 3-28

Rice-RE Crawford-GA, "Analysis of Citations Between Communication and Library and Information-Science Articles", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1992, Vol 29, pp 8-12

Richard-R Vanderpligt-J Devries-N, "Anticipated Affect and Behavioral Choice", BASIC AND APPLIED SOCIAL PSYCHOLOGY 1996, Vol 18, Iss 2, pp 111-129

Richards-JM, "Years Cited - An Alternative Measure of Scientific Accomplishment", SCIENTOMETRICS,1991, Vol 20, Iss 3, pp 427-438

Richards-JR, "Advances in Feline Health Research - Impact of Recent Richards-K Wrigley-N, "Geography in the United-Kingdom 1992-1996", GEOGRAPHICAL JOURNAL 1996, Vol 162, Iss MAR, pp 41-62

Richardson-JTE, "A British Evaluation of the Course Experience

Questionnaire", STUDIES IN HIGHER EDUCATION,1994, Vol 19, Iss 1, pp 59-68

Richman-DM, "Changing Peer-Review", CHEMICAL & ENGINEERING NEWS 1996, Vol 74, Iss 33, pp 4+

Rieh-HY, "Citation Analysis - A Case-Study of Korean Scientists and Engineers in Electrical and Electronics Engineering", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 165-171

Rikken-F Vos-R, "Searching for Adverse Drug-Reactions at the Margin of Scientific Fields - The Scientometric Detection of Peripheral But Potentially Innovative Developments in Pharmaceutical Research", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 187-199

Riley-PA, "Free-Radical Processes in Pathology - A Citation-Classic Commentary on Necrogenic Action of Carbon-Tetrachloride in the Rat - A Speculative Mechanism Based on Activation by Slater,T.F., and Free-Radical Mechanisms in Tissue-Injury by Slater,T.F.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 6, pp 9-9

Rinaldini-C, "Experience on Research Evaluation at the Joint Research-Center of the European-Commission", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 519-525

Rinia-EJ Delange-C Moed-HF, "Measuring National Output in Physics - Delimitation Problems", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 89-110

Rip-A, "Citation for Hughes,Thomas,P. 1990 Bernal Prize Recipient", SCIENCE TECHNOLOGY & HUMAN VALUES,1991, Vol 16, Iss 3, pp 382-386

Rip-A, "Citation for Latour,Bruno, ,1992 Bernal Prize Recipient", SCIENCE TECHNOLOGY & HUMAN VALUES,1993, Vol 18, Iss 3, pp 379-383

Rip-A, "The Republic of Science in the 1990s", HIGHER EDUCATION,1994, Vol 28, Iss 1, pp 3-23

Rivas-AL Deshler-D Colle-RD Gonzalez-RN Quimby-FW, "Indicators of Disciplinary Differentiation - Interdisciplinary Linkages and Adoption Rate of Biological Innovations", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 63-86

Roberts-J, "Naturalistic Inquiry for Library-Science - Methods and Applications for Research, Evaluation, and Teaching, by C.A. Mellon", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1991, Vol 79, Iss 3, pp 348-349

Roberts-J, "United-States-Congress Bypasses Peer-Review System", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6863, pp 1179-1179

Roberts-JC Fletcher-RH Fletcher-SW, "Effects of Peer-Review and Editing on the Readability of Articles Published in Annals of Internal-Medicine", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 119-121

Robertson-S Parker-G Byrne-S Wright-M, "An Exploration of the Quality of Peer-Review Group Activities Within Australasia", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY 1996, Vol 30, Iss 5, pp 660-666

Robertson-VJ, "Research and the Cumulation of Knowledge in Physical Therapy", PHYSICAL THERAPY,1995, Vol 75, Iss 3, pp 223-232

Robertus-JD, "The Tertiary Structure of Transfer-RNA - A

Citation-Classic Commentary on Structure of Yeast Phenylalanine Transfer-RNA at 3A Resolution, by Robertus,J.D., Ladner,J.E., Finch,J.T., Rhodes,D., Brown,R.S., Clark,B.F.C., and Klug,A.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 24, pp 11-11

Robins-LN, "Deviant Children Grown Up - A Citation-Classic Commentary on Deviant Children Grown Up - A Sociological and Psychiatric-Study of Sociopathic Personality by Robin,L.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 12, pp 10-10

Robins-LN, "Deviant Children Grown Up - A Citation-Classic Commentary on Deviant Children Grown Up - A Sociological and Psychiatric-Study of Sociopathic Personality by Robin,L.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 12, pp 10-10

Robins-RW Craik-KH, "A More Appropriate Test of the Kuhnian Displacement Thesis - Comment", AMERICAN PSYCHOLOGIST,1994, Vol 49, Iss 9, pp 815-816

Robins-RW Craik-KH, "Is There a Citation Bias in the Judgment and Decision Literature", ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES,1993, Vol 54, Iss 2, pp 225-244

Robinson-A, "Programs and Practices for Talented Students - Insights from Evaluation and Research", GIFTED CHILD QUARTERLY 1996, Vol 40, Iss 3, pp 119-120

Robinson-JC, "Payment Mechanisms, Nonprice Incentives, and Organizational Innovation in Health-Care", INQUIRY-THE JOURNAL OF HEALTH CARE ORGANIZATION PROVISION AND FINANCING,1993, Vol 30, Iss 3, pp 328-333

Robinson-JO, "A Rapid Measure of Sensation and Feelings - A Citation-Classic Commentary on the Reliability of a Linear Analog for Evaluating Pain by Revill,S.I., Robinson,J.O., Rosen,M. and Hogg,M.I.J.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 22, pp 8-8

Robinson-MD, "Applied Bibliometrics - Using Citation Analysis in the Journal Submission Process", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1991, Vol 42, Iss 4, pp 308-310

Roche-M Freites-Y, "Rise and Twilight of the Venezuelan Scientific Community", SCIENTOMETRICS,1992, Vol 23, Iss 2, pp 267-289

Rodes-J Asenjo-MA Fernandezcruz-L Lecha-M Ballesta-A Teres-J Figueras-J Salamero-M Balasch-J Coronas-R Font-J, "Analysis of the Contribution of Doctors with Grants to the Scientific Production of Hospital-Clinic-I-Provincial, Barcelona (Spain) (1980-1990)", MEDICINA CLINICA,1994, Vol 103, Iss 12, pp 465-469

Rodriguez-FL, "The Notion of Development and Behavioral-Analysis - The Search for a Work Program", REVISTA MEXICANA DE PSICOLOGIA,1993, Vol 10, Iss 1, pp 99-109

Rodriguez-JI Cai-DA, "When Your Epistemology Gets in the Way - A Response to Sprague", COMMUNICATION EDUCATION,1994, Vol 43, Iss 4, pp 263-272

Rodriguez-K Moreiro-JA, "The Growth and Development of Research in the Field of Ecology - As Measured by Dissertation Title Analysis", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 59-70

Roeckelein-JE, "Citation of Laws and Theories in Textbooks Across 112 Years of Psychology", PSYCHOLOGICAL REPORTS 1996, Vol 79,

Iss 3, pp 979-998

Roeckelein-JE, "Contributions to the History of Psychology .104. Eminence in Psychology as Measured by Name Counts and Eponyms", PSYCHOLOGICAL REPORTS 1996, Vol 78, Iss 1, pp 243-253

Roediger-HL, "Is Unreliability in Peer-Review Harmful", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 159-159

Roehling-MV, "Extracting Policy from Judicial Opinions - The Dangersof Policy Capturing in a Field Setting", PERSONNEL PSYCHOLOGY,1993, Vol 46, Iss 3, pp 477-502

Roessner-JD Porter-AL Newman-N Cauffiel-D, "Anticipating the Future High-Tech Competitiveness of Nations - Indicators for 28 Countries", TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE 1996, Vol 51, Iss 2, pp 133-149

Rogers-EM, "Rise of the Classical Diffusion-Model - A Citation-Classic Commentary on Communication of Innovations - A Cross-Cultural Approach by Rogers,E.M. and Shoemaker,F.F.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 28, pp 10-10

Rogers-JR, "Assessing Right-to-Die Attitudes - A Conceptually Guided Measurement Model", JOURNAL OF SOCIAL ISSUES 1996, Vol 52, Iss 2, pp 63-84

Rogers-LA Anderson-J, "A New Approach to Defining a Multidisciplinary Field of Science - The Case of Cardiovascular Biology", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 61-77

Rogers-PJ Hough-G, "Improving the Effectiveness of Evaluations - Making the Link to Organizational Theory", EVALUATION AND PROGRAM PLANNING 1995, Vol 18, Iss 4, pp 321-332

Rojahn-J Warren-VJ Ohringer-S, "A Comparison of Assessment Methods for Depression in Mental-Retardation", JOURNAL OF AUTISM AND DEVELOPMENTAL DISORDERS,1994, Vol 24, Iss 3, pp 305-313

Roman-A Mendez-A, "The Spanish Transition to Democracy Seen Through the Spanish Database Isoc", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 201-212

Roman-PM Blum-TC, "Alcohol - A Review of the Impact of Worksite Interventions on Health and Behavioral Outcomes", AMERICAN JOURNAL OF HEALTH PROMOTION 1996, Vol 11, Iss 2, pp 136-149

Romanini-MGM Redi-CA, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 184-184

Romer-PM Griliches-Z, "Implementing a National Technology Strategy with Self-Organizing Industry Investment Boards", BROOKINGS PAPERS ON ECONOMIC ACTIVITY,1993, Iss NSI2, pp 345-399

Rose-NR, "Experimental Autoimmune-Thyroiditis - A Citation-Classic Commentary on Studies on Organ Specificity .5. Changes in the Thyroid-Glands of Rabbits Following Active Immunization with Rabbit Thyroid Extracts by Rose,N.R. and Witebsky,E.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 6, pp 11-11

Roseboom-J Pardey-PG, "Measuring the Development of National Agricultural-Research Systems", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 169-190

Rosenberg-M, "Mixing Water, Oil, and Microorganisms - A Citation-Classic Commentary on Adherence of Bacteria to Hydrocarbons - A Simple Method for Measuring Cell-Surface Hydrophobicity by Rosenberg,M, Gutnick,D and Rosenberg,E", CURRENT CONTENTS/AGRICULTURE

BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 16, pp 8-8

Rosenberg-MS Bott-D Majsterek-D Chiang-B Simmons-D Gartland-D Wesson-C Graham-S Smithmyles-B Miller-M Swanson-HL Bender-W Rivera-D Wilson-R, "Minimum Standards for the Description Oi Participants in Learning-Disabilities Research", REMEDIAL AND SPECIAL EDUCATION,1994, Vol 15, Iss 1, pp 56-59

Rosenberg-N, "Introducing Technology into American History - A Citation-Classic Commentary on Technology and American Economic-Growth by Rosenberg,N.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 26, pp 8-8

Rosenberg-SA, "The End of the Beginning - A Citation-Classic Commentary on a Progress Report on the Treatment of 157 Patients with Advanced Cancer Using Lymphokine-Activated Killer-Cells and Interleukin-2 or High-Dose Interleukin-2 Alone by Rosenberg,S.A., Lotze,M.T., Muul,L.M., Chang,A.E., Avis,F.P., Leitman,S., Linehan,W.M., Robertson,C.N., Lee,R.E., Rubin,J.T., Seipp,C.A., Simpson,C.G., and White,D.E.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 18, pp 8-8

Rosenberg-SA, "The Development of Immunotherapy for Cancer - A Citation-Classic Commentary on Observations on the Systemic Administration of Autologous Lymphokine-Activated Killer-Cells and Recombinant Interleukin-2 to Patients with Metastatic Cancer by Rosenberg,S.A., Lotze,M.T., Muul,,L.M., Leitman,S., Chang,A.E., Ettinghausen,S.E., Matory,Y.L., Skibber,J.M., Shiloni,E., Vetto,J.T., Seipp,C.A., Simpson,C. and Reichert,C.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 16, pp 8-8

Rosenblatt-DS, "Brighter Prospects for Academic Medicine", CLINICAL AND INVESTIGATIVE MEDICINE-MEDECINE CLINIQUE ET EXPERIMENTALE,1992, Vol 15, Iss 6, pp 536-537

Rosenthal-NE, "A Decade of Sad and Light Therapy - A Citation-Classic Commentary on Seasonal Affective-Disorder - A Description of the Syndrome and Preliminary Findings with Light Therapy - By Rosenthal,N.E., Sack,D.A., Gillin,J.C., Lewy,A.J., Goodwin,F.K., Davenport,Y., Mueller,P.S., Newsome,D.A., Wehr,T.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 10, pp 8-8

Rosenthal-R, "Some Indexes of the Reliability of Peer-Review", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 160-160

Rosman-AS Schachner-JR, "A Better Citation System", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 614-614

Ross-D Whitehead-M Stevenson-J, "Use of Hormone Replacement Therapy - Authors Gave Distorted View Through Selective Citation", BRITISH MEDICAL JOURNAL 1996, Vol 313, Iss 7058, pp 686-687

Ross-J, "Citation-Classic - Catalysis by Metals", APPLIED CATALYSIS,1991, Vol 76, Iss 1, pp N3-N4

Ross-PF, "Concerning an Evaluation of the Peer-Review Process at Angewandte-Chemie", ANGEWANDTE CHEMIE-INTERNATIONAL EDITION IN ENGLISH,1993, Vol 32, Iss 7, pp 1030-1030

Rossler-W Meise-U, "New Trends in Psychiatric-Care", NEUROPSYCHIATRIE,1993, Vol 7, Iss 4, pp 171-175

Roth-M, "Alzheimers and Cortex Changes - A Citation-Classic Commentary on the Association Between Quantitative Measures of Dementia and of Senile Change in the Cerebral Gray-Matter of Elderly

Subjects by Blessed,G., Tomlinson,B.E., Roth,M.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 14, pp 8-8

Roth-M, "Alzheimers and Cortex Changes - A Citation-Classic Commentary on the Association Between Quantitative Measures of Dementia and of Senile Change in the Cerebral Gray-Matter of Elderly Subjects by Blessed,G., Tomlinson,B.E. and Roth,M.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 18, pp 10-10

Rothenberg-LF, "How to Design and Evaluate Research in Education, 2nd Edition, by J.R. Fraenkel, N.E. Wallen", EDUCATIONAL AND PSYCHOLOGICAL MEASUREMENT,1993, Vol 53, Iss 3, pp 859-864

Rothman-DS Chapman-D, "A Critical Analysis of Climate Change Policy Research", CONTEMPORARY POLICY ISSUES,1993, Vol 11, Iss 1, pp 88-98

Rothman-SM Olney-JW, "Excitotoxicity Comes of Age - A Citation-Classic Commentary on Glutamate and the Pathophysiology of Hypoxic-Ischemic Brain-Damage by Rothman,S.M., and Olney,J.M.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 40, pp 8-8

Rothstein-JM, "Peer-Review", PHYSICAL THERAPY,1991, Vol 71, Iss 2, pp 88-89

Rotton-J, "Research Productivity, Course Load, and Ratings of Instructors", PERCEPTUAL AND MOTOR SKILLS1990, Vol 71, Iss 3, pp 1388-1388

Rotton-J Levitt-M Foos-P, "Citation Impact, Rejection Rates, and Journal Value", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 8, pp 911-912

Rotton-J Levitt-M Foos-P, "Citation Impact, Rejection Rates, and Journal Value (Vol 48, Pg 911, ,1993)", AMERICAN PSYCHOLOGIST,1994, Vol 49, Iss 6, pp 504-504

Rouse-JJ, "Evaluation Research on Prison-Based Drug-Treatment Programs and Some Policy Implications", INTERNATIONAL JOURNAL OF THE ADDICTIONS,1991, Vol 26, Iss 1, pp 29-44

Rousseau-R, "Category Theory and Informetrics - Information Production Processes", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 77-87

Rousseau-R, "Double Exponential Models for 1st-Citation Processes", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 213-227

Rousseau-R, "Measuring Concentration - Sampling Design Issues, as Illustrated by the Case of Perfectly Stratified Samples", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 3-14

Rousseau-R, "Similarities Between Informetrics and Econometrics", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 385-387

Rousseau-R Rousseau-S, "Informetric Distributions - A Tutorial Review", CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE-REVUE CANADIENNE DES SCIENCES DE L INFORMATION ET DE BIBLIOTHECONOMIE,1993, Vol 18, Iss 2, pp 51-63

Rousseau-R Zhang-QQ, "Zipf Data on the Frequency of Chinese Words Revisited", SCIENTOMETRICS,1992, Vol 24, Iss 2, pp 201-220

Rowden-G, "Immune Defense Systems of the Skin - A Citation-Classic Commentary on Ia-Antigen Expression on Human Epidermal Langerhans Cells by Rowden,G., Lewis,M.G. and Sullivan,A.K. ", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 2, pp 8-8

Rowe-FB Crews-WD Finger-FW, "Buck,John,N. (1906-1983) - Did He Practically Establish Clinical-Psychology in Virginia", JOURNAL OF

CLINICAL PSYCHOLOGY,1993, Vol 49, Iss 3, pp 428-434
Roy-R, "Peer-Review or Performance Review", SCIENCE,1993, Vol 259, Iss 5091, pp 13-13
Rozhkov-S Mateev-P Melamed-S Angelov-G Mateev-N Kazansky-N Slavcheva-V Prodanova-E, "The Place of the Academy-of-Sciences in the Research Potential of Bulgaria - A Bibliometric Analysis", INTERNATIONAL FORUM ON INFORMATION AND DOCUMENTATION,1992, Vol 17, Iss 4, pp 21-27
Rozman-C Foz-M, "Medicina Clinica in the Science-Citation-Index", MEDICINA CLINICA,1992, Vol 98, Iss 1, pp 17-18
Rozman-C Foz-M Feliu-E, "Direction to 2000", MEDICINA CLINICA 1996, Vol 106, Iss 1, pp 19-20
Rubin-HR Redelmeier-DA Wu-AW Steinberg-EP, "How Reliable Is Peer-Review of Scientific Abstracts - Looking Back at the ,1991 Annual-Meeting of the Society of General Internal-Medicine", CLINICAL RESEARCH,1992, Vol 40, Iss 2, pp A604-A604
Rubin-HR Rogers-WH Kahn-KL Rubenstein-LV Brook-RH, "How Well Do Peer-Review Organizations Detect Problems in Hospital-Care", CLINICAL RESEARCH,1991, Vol 39, Iss 2, pp A607-A607
Rubin-HR Rogers-WH Kahn-KL Rubenstein-LV Brook-RH, "Watching the Doctor-Watchers - How Well Do Peer-Review Organization Methods Detect Hospital-Care Quality Problems", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1992, Vol 267, Iss 17, pp 2349-2354
Rubin-HR Weiss-S Djurfeldt-M Willan-A Mackenzie-T, "Comparing Canadian Hospitals Quality of Care Using Structured Implicit Peer-Review", CLINICAL RESEARCH,1993, Vol 41, Iss 2, pp A549-A549
Rubio-AV, "Scientific Production of Spanish Universities in the Fields of Social-Sciences and Language", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 3-19
Ruizprimo-MA Shavelson-RJ, "Rhetoric and Reality in Science Performance Assessments - An Update", JOURNAL OF RESEARCH IN SCIENCE TEACHING 1996, Vol 33, Iss 10, pp 1045-1063
Rumjanek-VM Leta-J, "An Evaluation of Immunology in Brazil (1981-1993)", BRAZILIAN JOURNAL OF MEDICAL AND BIOLOGICAL RESEARCH 1996, Vol 29, Iss 8, pp 923-931
Rupp-WT, "Qualitative Evaluation and Research Methods, by M.Q. Patton", JOURNAL OF BUSINESS RESEARCH,1994, Vol 30, Iss 2, pp 197-199
Russell-JM, "Back to the Future for Informetrics", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 407-410
Ruth-WP, "Provocative Outlook on the Long-Term Implication of Large Databases in Local Networks", LIBRI,1994, Vol 44, Iss 4, pp 279-288
Ryan-AG, "An Examination of the Place of Formal Recommendations in Naturalistic Evaluations", EVALUATION AND PROGRAM PLANNING,1993, Vol 16, Iss 2, pp 143-148
Ryan-B, "How Organizations Measure Success - The Use of Performance Indicators in Government, by N. Carter, R. Klein, P. Day", AUSTRALIAN JOURNAL OF PUBLIC ADMINISTRATION,1993, Vol 52, Iss 2, pp 252-255
Ryan-KJ, "Conversion of Androgens to Estrogens - A

Citation-Classic Commentary on Biological Aromatization of Steroids by Ryan,K.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 18, pp 10-10

Rye-DM Skinner-BJ, "Waldemar Lindgren Award for ,1991 Citation of Shelton,Kevin,L.", ECONOMIC GEOLOGY AND THE BULLETIN OF THE SOCIETY OF ECONOMIC GEOLOGISTS,1992, Vol 87, Iss 1, pp 219-222

Saaty-TL, "Highlights and Critical-Points in the Theory and Application of the Analytic Hierarchy Process", EUROPEAN JOURNAL OF OPERATIONAL RESEARCH,1994, Vol 74, Iss 3, pp 426-447

Saavedra-F Mackenzie-MR Pessot-R Krauskopf-M, "Size and Aging of the Scientific Community in Chile", SCIENTOMETRICS,1993, Vol 27, Iss 2, pp 105-117

Sadri-G Robertson-IT, "Self-Efficacy and Work-Related Behavior - A Review and Metaanalysis", APPLIED PSYCHOLOGY-AN INTERNATIONAL REVIEW-PSYCHOLOGIE APPLIQUEE-REVUE INTERNATIONALE,1993, Vol 42, Iss 2, pp 139-152

Safran-MA Wilson-RW, "Surveillance of HIV Knowledge, Attitudes, Beliefs, and Behaviors in the General-Population", PUBLIC HEALTH REPORTS 1996, Vol 111, Iss S1, pp 123-128

Safran-SP Safran-JS, "Intervention Assistance Programs and Prereferral Teams - Directions for the 21st Century", REMEDIAL AND SPECIAL EDUCATION 1996, Vol 17, Iss 6, pp 363-369

Sagel-SS, "Effective Audiovisual Presentation - Proper Citation of Sources - Reply", AMERICAN JOURNAL OF ROENTGENOLOGY,1991, Vol 157, Iss 3, pp 643-644

Saidman-LJ, "Unresolved Issues Relating to Peer-Review, Industry Support of Research, and Conflict-of-Interest", ANESTHESIOLOGY,1994, Vol 80, Iss 3, pp 491-492

Saiz-D Saiz-M, "A Bibliometric Approximation to Contemporary Catalan Psychology", INTERNATIONAL JOURNAL OF PSYCHOLOGY,1992, Vol 27, Iss 3-4, pp 532-533

Salganik-LH, "Apples and Apples - Comparing Performance Indicators for Places with Similar Demographic Characteristics", EDUCATIONAL EVALUATION AND POLICY ANALYSIS,1994, Vol 16, Iss 2, pp 125-141

Salzinger-K, "The One with the Most Citations Wins - Comment", AMERICAN PSYCHOLOGIST,1994, Vol 49, Iss 9, pp 816-816

Sampson-ZJ, "40-Years of the Physical-Review and Physical-Review Letters", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 219-226

Sanchezhernandez-A Pedraja-MJ Quinonesvidal-E Martinezsanchez-F, "A Historic Quantitative Approach to Psychophysiological Research - The First 3 Decades of the Journal Psychophysiology (1964-1993)", PSYCHOPHYSIOLOGY 1996, Vol 33, Iss 6, pp 629-636

Sancho-R, "Misjudgments and Shortcomings in the Measurement of Scientific Activities in Less-Developed-Countries", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 221-233

Sancho-R Bernal-G Galvez-L, "Approach to the Cuban Scientific Activity by Using Publication Based Quantitative Indicators (1985-1989)", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 297-312

Sancho-R Pastor-A Criado-E, "Bibliometric Approach to Research Performance in the Field of Refractory Materials Used in Iron and

Steelmaking Processes", SCIENTOMETRICS,1992, Vol 24, Iss 1, pp 115-136

Sanderson-P Scott-J Johnston-T Mainzer-J . Watanabe-L James-J, "Macshapa and the Enterprise of Exploratory Sequential Data-Analysis (Esda)", INTERNATIONAL JOURNAL OF HUMAN-COMPUTER STUDIES,1994, Vol 41, Iss 5, pp 633-681

Sandstrom-PE, "An Optimal Foraging Approach to Information-Seeking and Use", LIBRARY QUARTERLY,1994, Vol 64, Iss 4, pp 414-449

Santelices-B, "Use and Abuse of Citation and Impact Indexes", REVISTA CHILENA DE HISTORIA NATURAL,1994, Vol 67, Iss 3, pp 253-255

Sardar-Z, "Conquests, Chaos and Complexity - The Other in Modern and Postmodern Science", FUTURES,1994, Vol 26, Iss 6, pp 665-682

Sassen-MMA, "The Multinet-Growth Hypothesis - A Citation-Classic Commentary on Architecture and Growth of the Primary-Cell Wall in Some Plant Hairs and in the PhycomycesSporangiophore by Roelofsen,P.A., Houwink,A.L.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 32, pp 10-10

Sassen-MMA, "The Multinet-Growth Hypothesis - A Citation-Classic Commentary on Architecture and Growth of the Primary-Cell Wall in Some Plant Hairs and in the Phycomyces Sporangiophore by Roelofsen,P.A., Houwink,A.L.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 32, pp 10-10

Sato-R, "Cytochrome-P-450 - An Inconspicuous Start - A Citation-Classic Commentary on the Carbon Monoxide-Binding Pigment of Liver-Microsomes .1. Evidence for Its Hemoprotein Nature", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 8, pp 9-9

Satter-LD Roffler-RE, "Utilization of Protein by the Dairy-Cow - A Citation-Classic Commentary on Nitrogen Requirement and Utilization in Dairy-Cattle by Satter,L.D. and Roffler,R.E.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 18, pp 10-10

Sattin-A, "Methylxanthines as Antagonists of Adenosine Receptors - A Citation-Classic Commentary on the Effect of Adenosine and Adenine-Nucleotides on the Cyclic Adenosine 3',5'-Phosphate Content of Guinea-Pig Cerebral-Cortex Slices by Sattin,A., Rall,T.W.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 28, pp 8-8

Saucier-G, "Separating Description and Evaluation in the Structure of Personality Attributes", JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY,1994, Vol 66, Iss 1, pp 141-154

Saurer-W Weinberger-R, "Planetary-Nebulae - Some Statistics on a Continuously Growing Field and Its Contributors", SCIENTOMETRICS,1994, Vol 31, Iss 1, pp 85-95

Savitz-DA, "Is Statistical Significance Testing Useful in Interpreting Data", REPRODUCTIVE TOXICOLOGY,1993, Vol 7, Iss 2, pp 95-100

Savoy-J, "An Extended Vector-Processing Scheme for Searching Information in Hypertext Systems", INFORMATION PROCESSING & MANAGEMENT 1996, Vol 32, Iss 2, pp 155-170

Scanlan-BD, "Passengers, Drivers, and Traffic Cops on Peer-Review Road", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 71-73

Scanlan-TK Carpenter-PJ Simons-JP Schmidt-GW Keeler-B, "The

Sport Commitment Model - Measurement Development for the Youth-Sport Domain", JOURNAL OF SPORT & EXERCISE PSYCHOLOGY,1993, Vol 15, Iss 1, pp 16-38

Schacter-DL, "Memory Without Remembering - A Citation-Classic Commentary on Implicit Memory - History and Current Status by Schacter,D.L.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 50, pp 8-8

Schaefer-CW, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 184-184

Scheepers-P Eisinga-R Vansnippenburg-L, "Working-Class Authoritarianism - Evaluation of a Research Tradition and an Empirical-Test", NETHERLANDS JOURNAL OF SOCIAL SCIENCES,1992, Vol 28, Iss 2, pp 103-126

Schelling-TC, "Bargaining - A Citation-Classic Commentary on the Strategy of Conflict by Schelling,T.C.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 6, pp 8-8

Schena-FP Zoccali-C, "Bibliometric Analysis of the Scientific Productivity of the Italian-Society-of-Nephrology for a Period of 5 Consecutive Years (1990-1994)", NEPHROLOGY DIALYSIS TRANSPLANTATION 1996, Vol 11, Iss 11, pp 2359-2360

Scher-KS, "Making Peer-Review Statistically Accountable - Reply", AMERICAN JOURNAL OF SURGERY 1996, Vol 172, Iss 2, pp 224-224

Scher-KS Scottconner-CEH, "Making Peer-Review Statistically Accountable", AMERICAN JOURNAL OF SURGERY 1996, Vol 171, Iss 4, pp 441-444

Schiele-JH, "Submission Rates Among African-American Faculty - The Forgotten Side of Publication Productivity", JOURNAL OF SOCIAL WORK EDUCATION,1995, Vol 31, Iss 1, pp 46-54

Schiele-JH Francis-EA, "The Status of Former Cswe Ethnic-Minority Doctoral Fellows in Social-Work Academia", JOURNAL OF SOCIAL WORK EDUCATION 1996, Vol 32, Iss 1, pp 31-44

Schiff-W Arnone-W Cross-S, "Driving Assessment with Computer-Video Scenarios - More Is Sometimes Better", BEHAVIOR RESEARCH METHODS INSTRUMENTS & COMPUTERS,1994, Vol 26, Iss 2, pp 192-194

Schiller-C Wahner-A, "Stratospheric Oclo Measurements as a Poor Quantitative Indicator of Chlorine Activation - Comment", GEOPHYSICAL RESEARCH LETTERS 1996, Vol 23, Iss 9, pp 1053-1054

Schloman-BF Byrne-TJ, "Patterns of Information-Transfer in Health-Education - A Bibliometric Analysis of the Research Literature", HEALTH EDUCATION RESEARCH,1992, Vol 7, Iss 1, pp 117-128

Schmidt-H, "Prejudices and Discriminatory Behavior - A Metaanalysis", GRUPPENDYNAMIK-ZEITSCHRIFT FUR ANGEWANDTE SOZIALPSYCHOLOGIE,1992, Vol 23, Iss 4, pp 389-414

Schmoch-U, "Tracing the Knowledge Transfer from Science to Technology as Reflected in Patent Indicators", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 193-211

Schneider-D, "Handbook of Adolescent Sexuality and Pregnancy - Research and Evaluation Instruments, by J.J. Card", SOCIAL SCIENCE & MEDICINE,1994, Vol 38, Iss 9, pp 1317-1317

Schneider-HH, "Your Partners Keeper - Peer-Review Can Avoid Malpractice Disasters in the Making", ABA JOURNAL,1993, Vol 79, Iss

NOV, pp 104-104

Schneider-RJ Ackerman-PL Kanfer-R, "To Act Wisely in Human-Relations - Exploring the Dimensions of Social Competence", PERSONALITY AND INDIVIDUAL DIFFERENCES 1996, Vol 21, Iss 4, pp 469-481

Schneider-WC, "Intracellular-Distribution of Cytochrome-C - A Citation-Classic Commentary on Intracellular-Distribution of Enzymes .5. Further-Studies of the Distribution of Cytochrome-C in Rat-Liver Homogenates by Schneider,W.C. and Hogeboom,G.H.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 12, pp 10-10

Schneider-WH, "Blood-Group Research in Great-Britain, France, and the United-States Between the World-Wars", YEARBOOK OF PHYSICAL ANTHROPOLOGY 1995, Vol 38, pp 87-114

Schoch-N, "Relationship Between Citation Frequency and Journal Cost - A Comparison Between Pure and Applied Science Disciplines", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1994, Vol 31, pp 34-40

Schoch-N Abels-EG, "Using a Valuative Instrument for Decision-Making in the Cancellation of Science Journals in a University Setting", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1994, Vol 31, pp 41-50

Schoener-TW, "How Important Is Competition - A Citation-Classic Commentary on the Controversy over Interspecific Competition by Schoener,T.W.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 12, pp 10-10

Schoener-TW, "Overdispersed Niches on a Crowded Island - A Citation-Classic Commentary on the Anolis Lizards of Bimini - Resource Partitioning in a Complex Fauna by Schoener,T.W.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 6, pp 10-10

Schoener-TW, "Why Do Large-Size Differences Sometimes Evolve and Sometimes Not - A Citation-Classic Commentary on the Evolution of Bill Size Differences Among SympatricCongeneric Species of Birds by Schoener,T.W.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 48, pp 8-8

Schoepflin-U, "Scientometrics Research in the GDR, by M. Bonitz", NACHRICHTEN FUR DOKUMENTATION,1991, Vol 42, Iss 6, pp 403-404

Schoepflin-U, "Scientometrics Research in the FRG, by H.D. Daniel, R. Fisch", NACHRICHTEN FUR DOKUMENTATION,1991, Vol 42, Iss 6, pp 403-404

Schott-T, "Emerging and Declining Centers of Engineering Science - Japan and the United-States", KNOWLEDGE-CREATION DIFFUSION UTILIZATION,1994, Vol 15, Iss 4, pp 417-456

Schreiber-V, "The Medical Sciences in Czechoslovakia", TECHNOLOGY IN SOCIETY,1993, Vol 15, Iss 1, pp 131-136

Schroeder-C, "Nursings Response to the Crisis of Access, Costs, and Quality in Health-Care", ADVANCES IN NURSING SCIENCE,1993, Vol 16, Iss 1, pp 1-20

Schroeder-DS Laflin-MT Weis-DL, "Is There a Relationship Between Self-Esteem and Drug-Use - Methodological and Statistical Limitations of the Research", JOURNAL OF DRUG ISSUES,1993, Vol 23, Iss 4, pp 645-665

Schubert-A, "A Dictionary of Scientific Quotations, by A.L. Mackay", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 173-177

Schubert-A, "Little Scientometrics, Big Scientometrics - And Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 411-413

Schubert-A, "Quantitative Studies of Science a Current Bibliography", SCIENTOMETRICS,1991, Vol 20, Iss 3, pp 451-457

Schubert-A, "Scientometrics - A Citation Based Bibliography, 1993", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 273-280

Schubert-A, "Scientometrics - A Citation Based Bibliography, 1992", SCIENTOMETRICS 1996, Vol 36, Iss 1, pp 131-140

Schubert-A, "Scientometrics - A Citation Based Bibliography, 1990", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 155-163

Schubert-A Braun-T, "3 Scientometric Etudes on Developing-Countries as a Tribute to Moravcsik,Michael", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 3-19

Schubert-A Braun-T, "Reference-Standards for Citation Based Assessments", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 21-35

Schubert-A Braun-T, "Cross-Field Normalization of Scientometric Indicators", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 311-324

Schubert-A Glanzel-W, "Publication Dynamics - Models and Indicators", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 317-331

Schubert-A Maczelka-H, "All Quiet on the Eastern-Front - Analysis of the Publication, Reference and Citation Patterns of Zhurnal-Analiticheskoy-Khimii, 1990-91 Versus 1980-81", ANALYTICAL PROCEEDINGS,1994, Vol 31, Iss 4, pp 141-144

Schubert-A Maczelka-H, "Cognitive Changes in Scientometrics During the 1980s, as Reflected by the Reference Patterns of Its Core Journal", SOCIAL STUDIES OF SCIENCE,1993, Vol 23, Iss 3, pp 571-581

Schuller-T, "Performance Indicators in Higher-Education, by J. Johnes, J. Taylor", HIGHER EDUCATION QUARTERLY,1991, Vol 45, Iss 3, pp 280-282

Schulsinger-F, "From Invective to a Biomedical Disorder - A Citation-Classic Commentary on Psychopathy - Heredity and Environment by Schulsinger,F.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 6, pp 10-10

Schultz-CL Smyrnios-KX Grbich-CF Schultz-NC, "Caring for Family Caregivers in Australia - A Model of Psychoeducational Support", AGEING AND SOCIETY,1993, Vol 13, Iss MAR, pp 1-25

Schumacher-JE Siegal-SH Socol-JC Harkless-S Freeman-K, "Making Evaluation Work in a Substance-Abuse Treatment Program for Women with Children - Olivias House", JOURNAL OF PSYCHOACTIVE DRUGS 1996, Vol 28, Iss 1, pp 73-83

Schurmann-A Denzel-S Freyberger-HF Stiebel-U Dilling-H, "Sex-Differences in Rank Attainment Among Psychiatrists and Attitudes of Clinic Directors Towards Female and Male Psychiatrists", PSYCHIATRISCHE PRAXIS 1996, Vol 23, Iss 6, pp 262-265

Schutz-H Six-B, "More Than 7000 Pages of Social-Psychology - A Journal in Retrospect", ZEITSCHRIFT FUR SOZIALPSYCHOLOGIE,1994, Vol 25, Iss 1, pp 5-17

Schwandt-TA, "Naturalistic Inquiry for Library-Science - Methods and Applications for Research, Evaluation, and Teaching, by C.A. Mellon", LIBRARY QUARTERLY,1991, Vol 61, Iss 1, pp 87-88

Schwartz-CA, "Empirical-Analysis of Literature Loss", LIBRARY RESOURCES & TECHNICAL SERVICES,1994, Vol 38, Iss 2, pp 133-138

Schwartz-CA, "Research Productivity and Publication Output - An Interdisciplinary Analysis", COLLEGE & RESEARCH LIBRARIES,1991, Vol 52, Iss 5, pp 414-424

Schwartz-S Hellin-JL, "Measuring the Impact of Scientific Publications - The Case of the Biomedical Sciences", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 119-132

Schwert-GW, "The Journal of Financial Economics - A Retrospective Evaluation (1974-91)", JOURNAL OF FINANCIAL ECONOMICS,1993, Vol 33, Iss 3, pp 369-424

SCIENCE, "Science Indicators - How Federal-Agencies Spend Their R-and-D", SCIENCE 1996, Vol 272, Iss 5265, pp 1094-1094

SCIENTIST, "Citation Analysis Suggests Multinational Coauthorship Has Leveled Off (Reprinted from Science Watch, Jan-Feb, Pg 1-2, 1996)", SCIENTIST 1996, Vol 10, Iss 5, pp 13+

SCIENTIST, "Citation Analysis Reveals Leading Institutions, Scientists Researching AIDS", SCIENTIST 1996, Vol 10, Iss 15, pp 12-13

SCIENTIST, "Citation Data Identify Colon-Cancer, Mental-Health as Hot Research Areas", SCIENTIST 1996, Vol 10, Iss 8, pp 13-13

SCIENTIST, "Citation Records Show Uss Top Schools in Clinical Medicine Research (Vol 10, Pg 14, 1995)", SCIENTIST 1996, Vol 10, Iss 20, pp 12-12

SCIENTIST, "Citation Records Reveal Top Australian Universities in 21 Fields", SCIENTIST 1996, Vol 10, Iss 20, pp 13-13

SCIENTIST, Citation Study Reveals Moscow as Leader in Research Paper Publishing (Reprinted from Science Watch, DEC, ,1992)", SCIENTIST,1993, Vol 7, Iss 9, pp 15-15

SCIENTIST, Citations Reveal Leaders in Neuroscience (Reprinted from Sci Watch, Vol 5, Pg 1, ,1994)", SCIENTIST,1994, Vol 8, Iss 12, pp 15-15

SCIENTOMETRICS, "Center for Informetric Studies", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 381-381

SCIENTOMETRICS, "Peer-Review Based Evaluation and Foresight Exercises", SCIENTOMETRICS 1996, Vol 36, Iss 3, pp 397-420

SCIENTOMETRICS, "Swedish Biomedical Theses", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 255-258

Sclater-JG Francheteau-J, "Terrestrial Heat-Flow and Plate-Tectonics - A Citation-Classic Commentary on Implications of Terrestrial Heat-Flow Observations on Current Tectonic and Geochemical Models of the Crust and Upper Mantle of the Earth by Sclater,J., Francheteau,J.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 46, pp 10-10

Scott-JE, "Foundations of Chemical Morphology - A Citation-Classic Commentary on Differential Staining of Acid Glycosaminoglycans (Mucopolysaccharides) by Alcian Blue in Salt-Solutions by Scott,J.E., and Dorling,J.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 24, pp 9-9

Scott-JT, "Is It Worth Writing About", JOURNAL OF THE ROYAL SOCIETY OF MEDICINE,1993, Vol 86, Iss 1, pp 5-6

Scott-PV Smith-TC, "Definition of Authorship May Be Changed -

Peer Reviewers Should Be Identified at End of Each Published Paper", BRITISH MEDICAL JOURNAL 1996, Vol 313, Iss 7060, pp 821-821

Scriber-JM Slansky-F, "Nutritional Ecology and Evolutionary Entomology - A Citation-Classic Commentary on the Nutritional Ecology of Immature Insects by Scriber,J.M., and Slansky,F.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 6, pp 8-8

Seah-MP, "An Invitation from Apollo - A Citation-Classic Commentary on Grain-Boundary Segregation by Seah,M.P. and Hondros,E.D.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 10, pp 10-10

Seah-MP, "While Apollo Was Away a Citation-Classic Commentary on Quantitative Auger-Electron Spectroscopy and Electron Ranges - Seah,M.P.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 12, pp 8-8

SEARCH, Censorship or Peer-Review", SEARCH,1993, Vol 24, Iss 4, pp 93-93

Sears-DW Reid-JN, "Rural Strategies and Rural-Development Research - An Assessment", POLICY STUDIES JOURNAL,1992, Vol 20, Iss 2, pp 301-309

Seaton-AV, "Blowing the Whistle on Tourism Referees", TOURISM MANAGEMENT 1996, Vol 17, Iss 6, pp 397-399

Segall-SE Pearl-W, "Should Due-Process Be Part of Hospital Peer-Review", SOUTHERN MEDICAL JOURNAL,1993, Vol 86, Iss 3, pp 368-369

Seglen-PO, "Causal Relationship Between Article Citedness and Journal Impact", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 1, pp 1-11

Seglen-PO, "Citation Frequency and Journal Impact - Valid Indicators of Scientific Quality", JOURNAL OF INTERNAL MEDICINE,1991, Vol 229, Iss 2, pp 109-111

Seglen-PO, "Quantification of Scientific Article Contents", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 355-366

Seiken-J, "NSF Program Attempts to Address Concerns of Peer-Review Critics", SCIENTIST,1992, Vol 6, Iss 23, pp 23-23

Sekerak-RJ Bianchi-NA Omalley-DK Weinstock-JS Alexander-K, "Librarians Contract to Provide Bibliographic Support for a New Medical Text", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1995, Vol 83, Iss 1, pp 93-95

Selander-RK, "Ecological Radiation of the Sexes - A Citation-Classic Commentary on Sexual Dimorphism and Differential Niche Utilization in Birds by Selander,R.K.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 10, pp 10-10

Selander-RK, "Ecological Radiation of the Sexes - A Citation-Classic Commentary on Sexual Dimorphism and Differential Niche Utilization in Birds by Selander,R.K.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 10, pp 10-10

Selander-RK, "Genetic Drift in Isolated Populations - A Citation-Classic Commentary Indexing on Biochemical Polymorphism and Systematics in the Genus Peromyscus .1. Variation in the Old-Field

Mouse (Peromyscus-Polionotus) by Selander,R.K., Smith,M.H., Yang,S.Y., Johnson,W.E. and Gentry,J.B.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 14, pp 10-10

Selander-RK, "Genetic Drift in Isolated Populations - A Citation-Classic Commentary on Biochemical Polymorphism and Systematics in the Genus Peromyscus .1. Variation in the Old-Field Mouse (Peromyscus-Polionotus) by Selander,R.K., Smith,M.H., Yang,S.Y., Johnson,W.E., and Gentry,J.B.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 10, pp 9-9

Sellin-T Wolfgang-ME, "A Psychosocial Scaling of the Seriousness of Crime - A Citation-Classic Commentary on the Measurement of Delinquency by Sellin,T., and Wolfgang,M.E.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 8, pp 8-8

Sen-BK Lakshmi-VV, "Indian Periodicals in the Science-Citation-Index", SCIENTOMETRICS,1992, Vol 23, Iss 2, pp 291-318

Sen-BK Shailendra-K, "Evaluation of Recent Scientific-Research Output by a Bibliometric Method", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 31-46

Sen-L, "Clinical-Features of T-All - A Citation-Classic Commentary on Clinical Importance of Lymphoblasts with T-Markers in Childhood Acute-Leukemia by Sen,L, Borella,L.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 32, pp 8-8

Seng-LB Willett-P, "The Citedness of Publications by United-Kingdom Library-Schools", JOURNAL OF INFORMATION SCIENCE,1995, Vol 21, Iss 1, pp 68-71

Sengupta-IN, "Bibliometrics, Informetrics, Scientometrics and Librametrics - An Overview", LIBRI,1992, Vol 42, Iss 2, pp 75-98

Sengupta-IN Henzler-RG, "Citedness and Uncitedness of Cancer Articles", SCIENTOMETRICS,1991, Vol 22, Iss 2, pp 283-296

Sengupta-IN Kumari-L, "Bibliometric Analysis of AIDS Literature", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 297-315

Senter-R, "Factors in American State Government Spending on Research-and-Development", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 313-327

Serra-MP Bolumar-F Alonso-J Alvarezdardet-C, "Enclosed with Only One Toy", MEDICINA CLINICA,1994, Vol 103, Iss 18, pp 716-717

Service-RF, "Scientific Citations - Hhmi - A Dynasty in the Making", SCIENCE,1994, Vol 264, Iss 5165, pp 1528-1528

Sessler-J Chipperfield-MP Pyle-JA Toumi-R, "Stratospheric Oclo Measurements as a Poor Quantitative Indicator of Chlorine Activation - Reply", GEOPHYSICAL RESEARCH LETTERS 1996, Vol 23, Iss 9, pp 1055-1055

Seufert-W, "The Ancient-Art of Peer-Review", NEW SCIENTIST,1992, Vol 133, Iss 1802, pp 39-39

Sexton-RJ Sexton-TA, "Measuring Research Benefits in an Imperfect Market", AGRICULTURAL ECONOMICS 1996, Vol 13, Iss 3, pp 201-204

Shalini-R, "Citation Profiles to Improve Relevance in a 2-Stage Retrieval-System - A Proposal", INFORMATION PROCESSING & MANAGEMENT,1993, Vol 29, Iss 4, pp 463-470

Shapiro-F, "Errors of Context and Review of Eye-Movement Desensitization and Reprocessing Research", JOURNAL OF BEHAVIOR THERAPY AND EXPERIMENTAL PSYCHIATRY 1996, Vol 27, Iss.3, pp 313-317

Shapiro-FR, "Origins of Bibliometrics, Citation Indexing, and Citation Analysis - The Neglected Legal Literature", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 5, pp 337-339

Shapiro-T, "Psychoanalytic Facts - From the Editors Desk", INTERNATIONAL JOURNAL OF PSYCHO-ANALYSIS,1994, Vol 75, Iss DEC, pp 1225-1232

Sharpe-MN York-JL Knight-J, "Effects of Inclusion on the Academic-Performance of Classmates Without Disabilities - A Preliminary-Study", REMEDIAL AND SPECIAL EDUCATION,1994, Vol 15, Iss 5, pp 281-287

Shaw-D, "Bibliographic Database Searching by Graduate-Students in Language and Literature - Search Strategies, System Interfaces, and Relevance Judgments", LIBRARY & INFORMATION SCIENCE RESEARCH 1995, Vol 17, Iss 4, pp 327-345

Shaw-MC, "The Discipline of Nursing - Historical Roots, Current Perspectives, Future-Directions", JOURNAL OF ADVANCED NURSING,1993, Vol 18, Iss 10, pp 1651-1656

Shea-S Basch-CE Wechsler-H Lantigua-R, "The Washington-Heights Inwood Healthy Heart Program - A 6-Year Report from a Disadvantaged Urban Setting", AMERICAN JOURNAL OF PUBLIC HEALTH 1996, Vol 86, Iss 2, pp 166-171

Shear-MK Maser-JD, "Standardized Assessment for Panic Disorder Research - A Conference Report", ARCHIVES OF GENERAL PSYCHIATRY,1994, Vol 51, Iss 5, pp 346-354

Shelstad-KR Clevenger-FW, "Online Search Strategies of 3rd Year Medical-Students - Perception vs Fact", JOURNAL OF SURGICAL RESEARCH,1994, Vol 56, Iss 4, pp 338-344

Shepperd-JA, "Productivity Loss in Performance Groups - A Motivation Analysis", PSYCHOLOGICAL BULLETIN,1993, Vol 113, Iss 1, pp 67-81

Shields-WD, "Peer-Review of Medical Expert Witnesses - Reply", JOURNAL OF CHILD NEUROLOGY,1994, Vol 9, Iss 2, pp 217-217

Shields-WD, "Peer-Review of Expert Medical-Legal Testimony - A Proposal for Child Neurology", JOURNAL OF CHILD NEUROLOGY,1992, Vol 7, Iss 3, pp 237-239

Shifman-M, "Deriving Properties of Matter from the Vacuum-Structure -A Citation-Classic Commentary Ion QCD and Resonance Physics - Theoretical Foundations and QCD and Resonance Physics - Applications and QCD and Resonance Physics - The Rho-Omega Mixing by Shifman,M.A., Vainshtein,A.I., and Zakharov,V.I.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 34, pp 9-9

Ship-JA Duffy-V Jones-JA Langmore-S, "Geriatric Oral Health and Its Impact on Eating", JOURNAL OF THE AMERICAN GERIATRICS SOCIETY 1996, Vol 44, Iss 4, pp 456-464

Short-TG Oregan-A Lew-J Oh-TE, "Critical Incident Reporting in an Anesthetic Department Quality Assurance Program", ANAESTHESIA,1993, Vol 48, Iss 1, pp 3-7

Shortz-JL Worthington-EL Mccullough-ME Kurusu-T Bryant-W Devries-H, "Is There More to Counting Than What Meets the Eye - Comment", JOURNAL OF MARITAL AND FAMILY THERAPY,1994, Vol 20, Iss 2, pp 197-202

Shriberg-LD, "4 New Speech and Prosody-Voice Measures for Genetics Research and Other Studies in Developmental Phonological Disorders", JOURNAL OF SPEECH AND HEARING RESEARCH,1993, Vol 36, Iss 1, pp 105-140

Shulman-MS Robillard-RJ, "Accuracy in Reference Citations (Vol 78, Pg 616, ,1993)", ANESTHESIOLOGY,1993, Vol 79, Iss 2, pp 414-414

Shulman-MS Robillard-RJ, "Accuracy in Reference Citations", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 616-617

Shuster-S, "Skin Deep - A Citation-Classic Commentary on the Rate of Sebum Excretion in Man by Cunliffe,W.J. Shuster,S.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 10, pp 10-10

Sichel-HS, "Anatomy of the Generalized Inverse Gaussian-Poisson Distribution with Special Applications to Bibliometric Studies", INFORMATION PROCESSING & MANAGEMENT,1992, Vol 28, Iss 1, pp 5-17

Sichel-HS, "Note on a Strongly Unimodal Bibliometric Size Frequency-Distribution", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1992, Vol 43, Iss 4, pp 299-303

Siegal-FP, "The Recognition of AIDS - A Citation-Classic Commentary on Severe Acquired Immunodeficiency in Male-Homosexuals, Manifested by Chronic Perianal Ulcerative Herpes-Simplex Lesions by Siegal,F.P., Lopez,C., Hammer,G.S., Brown,A.E., Kornfeld,S.J., Gold,J., Hassett,J., Hirschman,S.Z., Cunninghamrundles,C., Adelsberg,B.R., Parham,D.M., Siegal,M., Cunninghamrundles,S., Armstrong,D.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 50, pp 10-10

Siegel-GB, "3 Federal Demonstration Projects - Using Monetary Performance Awards", PUBLIC PERSONNEL MANAGEMENT,1994, Vol 23, Iss 1, pp 153-164

Siegelman-SS, "Assassins and Zealots - Variations in Peer-Review - Special Report", RADIOLOGY,1991, Vol 178, Iss 3, pp 637-642

Siekevitz-P, "Citations and the Tenor of the Times", FASEB JOURNAL,1991, Vol 5, Iss 2, pp 139-139

Siekevitz-P, "Low Citation Rates - Who Is to Blame - Reply", FASEB JOURNAL,1991, Vol 5, Iss 8, pp 2217-2217

Sigogneau-A, "Between Policy Categories and Research Activities - Reviews and Journals to Describe Environment Networks", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 337-348

Sikorav-JL, "The Utility of Scientific Papers", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 49-68

Silagy-CA Jewell-D Mant-D, "An Analysis of Randomized Controlled Trials Published in the Us Family Medicine Literature, 1987-,1991", JOURNAL OF FAMILY PRACTICE,1994, Vol 39, Iss 3, pp 236-242

Silva-M, "Importance of Graduate Programs for Scientific Output in Chile", BOLETIN DE LA SOCIEDAD CHILENA DE QUIMICA,1994, Vol 39, Iss 1, pp 2-5

Silver-K, "The Yellowed Archives of Yellowcake", PUBLIC HEALTH REPORTS 1996, Vol 111, Iss 2, pp 116-127

Simmons-P, "Science Under Scarcity - Principles and Practice for Agricultural-Research Evaluation and Priority Setting, by J.M. Alston, G.W. Norton, P.G. Pardey", AUSTRALIAN JOURNAL OF AGRICULTURAL ECONOMICS 1995, Vol 39, Iss 3, pp 298-300

Simon-HR, "From Bibliometrics to Diversity - A Personal View", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 6, pp 457-461

Simonetti-R Archibugi-D Evangelista-R, "Product and Process Innovations - How Are They Defined - How Are They Quantified", SCIENTOMETRICS,1995, Vol 32, Iss 1, pp 77-89

Sinacore-JM Chang-RW Falconer-J, "Seeing the Forest Despite the Trees - The Benefit of Exploratory Data-Analysis to Program-Evaluation Research", EVALUATION & THE HEALTH PROFESSIONS,1992, Vol 15, Iss 2, pp 131-146

Singh-UN Arunachalam-S, "Publication and Citation Patterns in the Literature of Liquid-Crystals with Special Reference to the Contribution of India, Canada, Japan, United-Kingdom and the Soviet-Union", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 197-220

Singh-UN Arunachalam-S, "High Tech Science in Middle Level Countries - Publication and Citation Patterns in the Literature of Holography", JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH,1991, Vol 50, Iss 7, pp 516-532

Sirotnik-KA Durden-PC, "The Validity of Administrator Performance Assessment Systems - The Adi as a Case-in-Point", EDUCATIONAL ADMINISTRATION QUARTERLY 1996, Vol 32, Iss 4, pp 539-564

Sittig-DF, "Identifying a Core Set of Medical Informatics Serials - An Analysis Using the Medline Database", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION 1996, Vol 84, Iss 2, pp 200-204

Sivaram-CA Johnson-S Tirmizi-SN Robertson-V Garcia-D Sorrells-E, "Morning Report - A Forum for Reporting Adverse Drug-Reactions", JOINT COMMISSION JOURNAL ON QUALITY IMPROVEMENT 1996, Vol 22, Iss 4, pp 259-263

Six-J Bustamante-MC, "Bibliometric Analysis of Publications in Experimental Particle Physics on Cosmic-Rays and with Accelerators", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 25-37

Sizer-J Spee-A Bormans-R, "The Role of Performance Indicators in Higher-Education", HIGHER EDUCATION,1992, Vol 24, Iss 2, pp 133-155

Skinner-DA, "Family Preservation Services - Research and Evaluation, by K. Wells, D.E. Biegel", JOURNAL OF MARRIAGE AND THE FAMILY,1992, Vol 54, Iss 2, pp 468-469

Slamecka-NJ, "Delineation of the Generation Effect - A Citation-Classic Commentary on the Generation Effect - Delineation of a Phenomenon by Slamecka,N.J., Graf,P.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 18, pp 10-10

SLEEP, "Bibliography of Recent Literature in Sleep Research - Citations Retrieved by Brain-Information-Service", SLEEP 1996, Vol 19, Iss 1, pp 77-82

SLEEP, "Citations Retrieved by Brain Information-Service", SLEEP 1996, Vol 19, Iss 7, pp 602-608

SLEEP, Bibliography of Recent Literature in Sleep Research - Citations Retrieved by Brain Information-Service", SLEEP,1993, Vol 16, Iss 5, pp 500-509

Sloane-D Morgan-SP, "An Introduction to Categorical-Data Analysis", ANNUAL REVIEW OF SOCIOLOGY 1996, Vol 22, pp 351-375

Slomanson-WR, "The Bluebook, by A, Uniform, System, Of, Citation, 15th, Edition", JOURNAL OF LEGAL EDUCATION,1992, Vol 42, Iss 1, pp 147-149

Slots-J, "Long in the Tooth - A Citation-Classic Commentary on Predominant Cultivable Organisms in Juvenile Periodontitis by Slots,J.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 26, pp 8-8

Slots-J, "Microflora of Periodontitis - A Citation-Classic Commentary on Predominant Cultivable Microflora of Advanced Periodontitis by Slots,J.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 2, pp 8-8

Small-H, "A Sci-Map Case-Study - Building a Map of AIDS Research", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 229-241

Small-H, "Cogitations on Cocitation - A Citation-Classic Commentary on Cocitation in Scientific Literature - NewRelationship Between 2 Documents by Small,H.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 10, pp 10-10

Small-H, "Macrolevel Changes in the Structure of Cocitation Clusters - 1983-1989", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 5-20

Small-HG, "Identifying Related Patents Using Citation Coupling - A Comparison of 3 Methods", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 47-CINF

Smikle-CB Fiedler-E Sorem-KA Spencer-DK Satin-AJ, "The Impact of Sexual Abuse on Job Attrition in Military Recruits", MILITARY MEDICINE 1996, Vol 161, Iss 3, pp 146-148

Smiraglia-RP Leazer-GH, "Reflecting the Maturation of a Profession - 35 Years of Library Resources and Technical-Services", LIBRARY RESOURCES & TECHNICAL SERVICES,1994, Vol 38, Iss 1, pp 27-46

Smith-AD Winkler-H, "Lots of Pure Pink Chromaffin Granules - A Citation-Classic Commentary on a Simple Method for the Isolation of Adrenal Chromaffin Granules on a Large-Scale by Smith,A.D. and Winkler,H.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 50, pp 9-9

Smith-AG, "Charting the Vanished Tethyan Ocean - A Citation-Classic Commentary on Alpine Deformation and the Oceanic Areas of the Tethys, Mediterranean, and Atlantic by Smith,A.G.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 50, pp 8-8

Smith-GB Schwebel-AI Dunn-RL Mciver-SD, "The Role of Psychologists in the Treatment, Management, and Prevention of Chronic Mental-Illness", AMERICAN PSYCHOLOGIST,1993, Vol 48, Iss 9, pp 966-971

Smith-H, "ISI Journal Citations and Impact Factors for ,1992", PLANT CELL AND ENVIRONMENT,1994, Vol 17, Iss 9, pp 987-987

Smith-LC, "Citation Life-Cycle - Use of Citations Through Time, byV. Cano", LIBRARY & INFORMATION SCIENCE RESEARCH,1994, Vol 16, Iss 1, pp 69-71

Smith-MD Devine-JA Sheley-JF, "Crime and Unemployment - Effects Across Age and Race Categories", SOCIOLOGICAL PERSPECTIVES,1992, Vol 35, Iss 4, pp 551-572

Smith-R, "Peer-Review Is OK", BRITISH MEDICAL JOURNAL,1991, Vol 302, Iss 6774, pp 431-431

Smith-R, "Promoting Research into Peer-Review", BRITISH MEDICAL JOURNAL,1994, Vol 309, Iss 6948, pp 143-144
Smith-R Walker-R, "The Role of Performance Indicators in Housing Management - A Critique", ENVIRONMENT AND PLANNING A,1994, Vol 26, Iss 4, pp 609-621
Smith-SJ, "Drug Information Bulletins - An Analysis of Citations", JOURNAL OF INFORMATION SCIENCE 1996, Vol 22, Iss 5, pp 375-380
Smith-WA, "Evaluating Research, Technology and Development in Canadian Industry - Meeting the Challenges of Industrial-Innovation", SCIENTOMETRICS 1995, Vol 34, Iss 3, pp 527-539
Smithcohen-D, "Developing an in-House Database from Online Sources", SPECIAL LIBRARIES,1993, Vol 84, Iss 1, pp 9-17
Snavely-L Clark-K, "What Users Really Think - How They See and Find Serials in the Arts and Sciences", LIBRARY RESOURCES & TECHNICAL SERVICES 1996, Vol 40, Iss 1, pp 49+
Snell-EE, "Structure and Function of Vitamin-B6 - A Citation-Classic Commentary on Chemical-Structure in Relation to Biological-Activities of Vitamin-B6 by Snell,E.E.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 38, pp 11-11
Snider-WD, "AIDS and the Nervous-System - A Citation-Classic Commentary on Neurological Complications of Acquired-Immune-Deficiency-Syndrome - Analysis of 50 Patients by Snider,W.D., Simpson,D.M., Nielsen,S., Gold,J.W.M, Metroka,C.E., and Posner,J.B.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 32, pp 8-8
Snizek-WE, "Some Observations on the Use of Bibliometric Indicators in the Assignment of University Chairs", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 117-120
Snizek-WE Oehler-K Mullins-NC, "Textual and Nontextual Characteristics of Scientific Papers - Neglected Science Indicators", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 25-35
Snowdon-J Miller-R Vaughan-R, "Behavioral-Problems in Sydney Nursing-Homes", INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY 1996, Vol 11, Iss 6, pp 535-541
Snyder-DK Rice-JL, "Theres More to Counting Than Meets the Eye - Comment", JOURNAL OF MARITAL AND FAMILY THERAPY,1994, Vol 20, Iss 2, pp 191-196
Snyder-M Berry-F Mavima-P, "Gender Policy in Development Assistance - Improving Implementation Results", WORLD DEVELOPMENT 1996, Vol 24, Iss 9, pp 1481-1496
Sodergard-P, "Why Does Finland Make So Many International Ilds Requests", INTERLENDING & DOCUMENT SUPPLY 1996, Vol 24, Iss 3, pp 12+
Soderqvist-T Silverstein-AM, "Studying Leadership and Subdisciplinary Structure ofScientific Disciplines - Cluster-Analysis of Participation in Scientific Meetings", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 243-258
Soderqvist-T Silverstein-AM, "Participation in Scientific Meetings - A New Prosopographical Approach to the Disciplinary History of Science - The Case of Immunology, 1951-72", SOCIAL STUDIES OF SCIENCE,1994, Vol 24, Iss 3, pp 513-548
Sodha-RJ Vanamelsvoort-T, "Multi-Database Searches in Biomedicine - Citation Duplication and Novelty Assessment Using

Carbamazepine as an Example", JOURNAL OF INFORMATION SCIENCE,1994, Vol 20, Iss 2, pp 139-141

Soehner-CB Wray-ST Richards-DT, "The Landmark Citation Method - Analysis of a Citation Pattern as a Collection Assessment Method", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1992, Vol 80, Iss 4, pp 361-366

Soltis-DE, "Starch-Gel Electrophoresis of Enzymes - Crocker,Betty Style - A Citation-Classic Commentary on Starch-Gel Electrophoresis of Ferns - A Compilation of Grinding Buffers, Gel and Electrode Buffers, and Staining Schedules by Soltis,D.E., Haufler,C.H., Darrow,D.C., Gastony,G.J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 50, pp 8-8

Sommer-R, "Serving 2 Masters - Center for Consumer Research at the University-of-California, Davis, 1976-,1992", JOURNAL OF CONSUMER AFFAIRS,1994, Vol 28, Iss 1, pp 170-186

Sondergaard-M, "Hofstede Consequences - A Study of Reviews, Citations and Replications", ORGANIZATION STUDIES,1994, Vol 15, Iss 3, pp 447-456

Sonnad-S Borgatta-EF, "Evaluation Research and Social Gerontology", RESEARCH ON AGING,1992, Vol 14, Iss 2, pp 267-280

Sonnenberg-FA Roberts-MS Tsevat-J Wong-JB Barry-M Kent-DL, "Toward a Peer-Review Process for Medical Decision-Analysis Models", MEDICAL CARE,1994, Vol 32, Iss 7, pp JS52-JS64

Sonnert-G, "What Makes a Good Scientist - Determinants of Peer Evaluation Among Biologists", SOCIAL STUDIES OF SCIENCE,1995, Vol 25, Iss 1, pp 35-55

Sorel-L, "Solving Seizures - A Citation-Classic Commentary on About 21 Cases of Hypsarhythmia of Gibbs - His Spectacular Treatment with the ACTH by Sorel,L. and Dusaucybauloye,A.M. ", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 42, pp 10-10

Soto-G Torozambrana-W Belfiore-PJ, "Comparison of 2 Instructional Strategies on Social Skills Acquisition and Generalization Among Individuals with Moderate and Severe Mental-Retardation Working in a Vocational Setting - A Meta-Analytical Review", EDUCATION AND TRAINING IN MENTAL RETARDATION AND DEVELOPMENTAL DISABILITIES,1994, Vol 29, Iss 4, pp 307-320

Southgate-DAT, "Standards of Peer Reviewing", BRITISH JOURNAL OF NUTRITION,1994, Vol 72, Iss 1, pp 1-2

Southgate-DAT, "The Ethics of Peer-Review", BRITISH JOURNAL OF NUTRITION,1992, Vol 67, Iss 3, pp 303-304

Souza-GS Cruz-ER Quirino-TR, "The Measurement and Assessment of Quality in Agricultural-Research Institutions", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 159-182

Sowers-AE, "Peer-Review", SCIENTIST 1996, Vol 10, Iss 7, pp 13-13

Spanswick-RM, "Creating Plant Proticity - A Citation-Classic Commentary on Electrogenic Ion Pumps - Spanswick,RM", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 22, pp 8-8

Sparrow-S Robinson-J, "The Use and Limitations of Phaneufs Nursing Audit", JOURNAL OF ADVANCED NURSING,1992, Vol 17, Iss 12, pp

1479-1488
Sparrow-WA Sparrow-HT, "Trends in Motor Behavior Research - A Study Based on Citation Analysis", JOURNAL OF HUMAN MOVEMENT STUDIES,1991, Vol 21, Iss 4, pp 183-199
Spence-JT, "The 2nd Sex - A Citation-Classic Commentary on Masculinity and Femininity - Their Psychological Dimensions, Correlates, and Antecedents by Spence,J.T., and Helmreich,R.L.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 18, pp 8-8
Spenkelink-GPJ Besuijen-K Brok-J, "An Instrument for the Measurement of the Visual Quality of Displays", BEHAVIOUR & INFORMATION TECHNOLOGY,1993, Vol 12, Iss 4, pp 249-260
Spittal-MJ Findlay-GP Spencer-I, "A Prospective Analysis of Critical Incidents Attributable to Anesthesia", INTERNATIONAL JOURNAL FOR QUALITY IN HEALTH CARE 1995, Vol 7, Iss 4, pp 363-371
Spitzer-WO, "Is Peer-Reviewing Fair - Comment", JOURNAL OF CLINICAL EPIDEMIOLOGY,1994, Vol 47, Iss 7, pp 819-820
Spodick-DH, "Evidence-Based Medicine - Letters Pages Are Essential for Peer-Review", BRITISH MEDICAL JOURNAL 1996, Vol 312, Iss 7046, pp 1611-1611
Spruit-HC, "A Curve of Growth for Astronomers on the Citation-Index", QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY 1996, Vol 37, Iss 1, pp 1-9
Sprunt-E, "SPE Peer-Review Critique - Reply", JOURNAL OF PETROLEUM TECHNOLOGY,1994, Vol 46, Iss 7, pp 563-563
Squires-BP, "Citation Rate - A Measure of Excellence", CANADIAN MEDICAL ASSOCIATION JOURNAL,1992, Vol 146, Iss 3, pp 341-341
Squires-BP, "Does Your Manuscript Fit in", CANADIAN MEDICAL ASSOCIATION JOURNAL,1992, Vol 146, Iss 4, pp 463-463
Squires-BP, "The Role of the Editor in Peer-Review", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 87-89
Srinivasan-P, "Query Expansion and Medline", INFORMATION PROCESSING & MANAGEMENT 1996, Vol 32, Iss 4, pp 431-443
Srinivasan-P, "Retrieval Feedback in Medline", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION 1996, Vol 3, Iss 2, pp 157-167
Stack-S, "The Class of 1976 - Publication and Type of Location", SOCIOLOGICAL SPECTRUM,1994, Vol 14, Iss 3, pp 293-298
Standing-L Maclean-M, "Contributions to the History of Psychology .78. Citation Overlap Between Histories of Animal Behavior Studies", PSYCHOLOGICAL REPORTS,1991, Vol 68, Iss 3, pp 707-710
Stankus-T, "Avoiding a Rush to a Verdict of Guilty - The Treatment of Third-World Science by First-World Publishers and Librarians", RQ 1996, Vol 35, Iss 4, pp 467-475
Stanley-G Reynolds-P, "Similarity Grouping of Australian Universities", HIGHER EDUCATION,1994, Vol 27, Iss 3, pp 359-366
Starfield-B Powe-NR Weiner-JR Stuart-M Steinwachs-D Scholle-SH Gerstenberger-A, "Costs vs Quality in Different Types of Primary-Care Settings", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 24, pp 1903-1908
Starr-C, "Is Peer-Review Unbiased", NATURE,1992, Vol 357, Iss 6377, pp 354-354
Starzl-TE, "The Emergence of Liver-Transplantation - A

Citation-Classic Commentary on Evolution of Liver-Transplantation by Starzl,T.E., Iwatsuki,S., Vanthiel,D.H., Gartner,J.C., Zitelli,B.J., Malatack,J.J., Schade,R.R., Shaw,B.W., Hakala,T.R., Rosenthal,J.T., and Porter,K.A.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 36, pp 8-8

Starzl-TE Murase-N Demetris-AJ Qian-SG, "Microchimerism - Inaccurate Literature Citations", TRANSPLANTATION 1996, Vol 62, Iss 5, pp 703-703

Stavric-S Speirs-J, "Discovery of Verotoxin - A Citation-Classic Commentary on Vero Response to a Cytotoxin of Escherichia-Coli by Konowalchuk,J., Speirs,J.I., and Stavric,S.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 34, pp 8-8

Stebelman-S, "Analysis of Retrieval Performance in 4 Cross-Disciplinary Databases - Article1St, Faxon Finder, Uncover, and a Locally Mounted Database", COLLEGE & RESEARCH LIBRARIES,1994, Vol 55, Iss 6, pp 562-567

Stein-E, "Peer-Review in a New-York Chapter of the Acnm 1987-1994", JOURNAL OF NURSE-MIDWIFERY 1996, Vol 41, Iss 5, pp 401-404

Steinberg-JJ, "The State of Biomedical Radiation Research as Demonstrated by Publications, Funding and Manpower Activity - An Analytical Example of Utilizing Online Medical Informatics", SCIENTOMETRICS,1993, Vol 27, Iss 3, pp 283-294

Steitz-JA, "Messenger RNA-Ribosomal-RNA Base-Pairing During Translation Initiation - A Citation-Classic Commentary on How Ribosomes Select Initiator Regions in Messenger-RNA - Base-Pair Formation Between the 3' Terminus of 16S Ribosomal-RNA and the Messenger-RNA During Initiation of Protein-Synthesis in Escherichia-Coli by Steitz,J.A.,Jukes,K.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 50, pp 9-9

Stephan-PE, "The Economics of Science", JOURNAL OF ECONOMIC LITERATURE 1996, Vol 34, Iss 3, pp 1199-1235

Stephan-PE Levin-SG, "Age and the Nobel-Prize Revisited", SCIENTOMETRICS,1993, Vol 28, Iss 3, pp 387-399

Stephan-PE Levin-SG, "Inequality in Scientific Performance - Adjustment for Attribution and Journal Impact", SOCIAL STUDIES OF SCIENCE,1991, Vol 21, Iss 2, pp 351-368

Stephan-PE Levin-SG, "Property-Rights and Entrepreneurship in Science", SMALL BUSINESS ECONOMICS 1996, Vol 8, Iss 3, pp 177-188

Stephen-T Harrison-TM, "Comserve - Moving the Communication Discipline Online", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 10, pp 765-770

Stephens-IE, "Citation Indexes Improve Bibliography in Technical Communication", JOURNAL OF TECHNICAL WRITING AND COMMUNICATION,1991, Vol 21, Iss 2, pp 117-125

Stephenson-AG, "Flower and Fruit Abortion - A Citation-Classic Commentary on Flower and Fruit Abortion - Proximate Causes and Ultimate Functions by Stephenson,A.G.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 50, pp 8-8

Stephenson-MS, "The Canadian-Library-Journal, 1981-91 - An Analysis", CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE-REVUE CANADIENNE DES SCIENCES DE L INFORMATION ET DE BIBLIOTHECONOMIE,1993,

Vol 18, Iss 2, pp 1-18

Sternlieb-I Scheinberg-IH, "Prevention of Wilsons-Disease a Citation-Classic Commentary on Wilsons-Disease in Asymptomatic Patients by Sternlieb,I. Scheinberg,I.H.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 6, pp 8-8

Stevens-CA Finlay-PN, "A Research Framework for Group Support Systems", GROUP DECISION AND NEGOTIATION 1996, Vol 5, Iss 4-6, pp 521-543

Stewart-GR, "A Review Written in NearRecord Time - A Citation-Classic Commentary on Heavy-Fermion Systems by Stewart,G.R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 32, pp 8-8

Stewart-GR, "Glutamine-Synthetase Isoforms of Higher-Plants - A Citation-Classic Commentary on Glutamine Synthetases of Higher-Plants - Evidence for a Specific Isoform Content Related to Their Possible Physiological-Role and Their Compartmentation Within the Leaf by Mcnally,S.F., Hirel,B., Gadal,P., Mann,A.F., and Stewart,G.R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 2, pp 8-8

Stewart-JA, "The Poisson-Lognormal Model for Bibliometric Scientometric Distributions", INFORMATION PROCESSING & MANAGEMENT,1994, Vol 30, Iss 2, pp 239-251

Stewart-RI Milligan-GA Louw-JA, "Evaluation of Research Publications in South-Africa", SOUTH AFRICAN JOURNAL OF SCIENCE,1992, Vol 88, Iss 3, pp 145-146

Steynberg-S, "Citation Analysis as a Method in the Qualitative Evaluation of Research", SOUTH AFRICAN JOURNAL OF SCIENCE,1993, Vol 89, Iss 11-12, pp 531-531

Steynberg-S Rossouw-SF, "Testing ORR Document-Delivery Test on Biomedical Journals in South-Africa", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION,1995, Vol 83, Iss 1, pp 78-84

Stiefel-EI, "Molybdenum in Biology and Chemistry - A Citation-Classic Commentary on the Coordination and Bioinorganic Chemistry of Molybdenum, by Stiefel,E.I.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 26, pp 8-8

Stigler-SM, "Citation Patterns in the Journals of Statistics and Probability", STATISTICAL SCIENCE,1994, Vol 9, Iss 1, pp 94-108

Still-J, "The Anthropology of Online Search Strategy Formation - A Study of 4 Countries", ONLINE & CDROM REVIEW 1996, Vol 20, Iss 2, pp 59-66

Stock-WG, "Economic Information by Informetric Online Retrieval", NACHRICHTEN FUR DOKUMENTATION,1992, Vol 43, Iss 5, pp 301-315

Stoeva-L Shekerdzhiiska-I, "Bibliometric Analysis of Publications on Superconductivity", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 1-ORGANIZATSIYA I METODIKA INFORMATSIONNOI RABOTY,1993, Iss 5, pp 20-23

Stoker-D, "Editorial - Who Assesses the Assessors", JOURNAL OF LIBRARIANSHIP AND INFORMATION SCIENCE 1996, Vol 28, Iss 1, pp 3-6

Stone-P, "Ghettoized and Marginalized - The Coverage of Racial and Ethnic-Groups in Introductory Sociology Texts", TEACHING SOCIOLOGY 1996, Vol 24, Iss 4, pp 356-363

Stone-R, "Science Funding - Peer-Review Catches Congressional Flak", SCIENCE,1992, Vol 256, Iss 5059, pp 959-959

Stone-R, "Ukraine - Cash-Starved Researchers to Undergo Trial by Peer-Review", SCIENCE 1996, Vol 271, Iss 5257, pp 1802-1803

Straub-DW Ang-S Evaristo-R, "Normative Standards for Is Research", DATA BASE,1994, Vol 25, Iss 1, pp 21-34

Strauss-ES, "Peer-Review Reconsidered", TECHNOLOGY REVIEW,1992, Vol 95, Iss 3, pp 6-7

Strauss-HS, "Errors in Citations in Foreign-Languages", JOURNAL OF PEDIATRICS,1993, Vol 123, Iss 2, pp 336-336

Streefland-PH Ahmed-H Nafisa-M Barman-DC Arefeen-HK, "Credit and Conscientization - Effects of Different Development Approaches in Bangladesh", PUBLIC ADMINISTRATION AND DEVELOPMENT,1993, Vol 13, Iss 2, pp 153-169

Streufert-S Pogash-RM Gingrich-D Kantner-A Lonardi-L Severs-W Landis-R Roache-J, "Alcohol and Complex Functioning", JOURNAL OF APPLIED SOCIAL PSYCHOLOGY,1993, Vol 23, Iss 11, pp 847-866

Streufert-S Satish-U Pogash-R Gingrich-D Landis-JR Lonardi-L Miller-J Severs-W Roache-JD, "Effects of Alprazolam on Complex Human Functioning", JOURNAL OF APPLIED SOCIAL PSYCHOLOGY 1996, Vol 26, Iss 21, pp 1912-1930

Stroebe-W, "Social-Psychology in the German-Speaking Countries and Its Journal - Personal Reflections on the 25th Anniversary of the Zeitschrift-Fur-Sozialpsychologie", ZEITSCHRIFT FUR SOZIALPSYCHOLOGIE,1994, Vol 25, Iss 1, pp 36-42

Stromberg-AG Getmantseva-EV, "Development of Electroanalytical Chemistry in the Period of 1979-1989 - A Scientometric Investigation", JOURNAL OF ANALYTICAL CHEMISTRY OF THE USSR,1992, Vol 47, Iss 1, pp 62-69

Stromberg-AG Nazarov-BF, "Theory of Electroanalytical Chemistry - Development in the Last 5 Years, Current State, and Prospects -Scientometric Aspect", JOURNAL OF ANALYTICAL CHEMISTRY,1994, Vol 49, Iss 9, pp 814-819

Sturtevant-FM, "A Lesson to Be Gained from Basic Research Programs - A Citation-Classic Commentary on Pharmacology of a New Steroid That Blocks Salt Activity of Aldosterone and Deoxycorticosterone by Kagawa,C.M., Sturtevant,F.M., and Vanarman,C.G.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 28, pp 9-9

Su-LT, "Is Relevance an Adequate Criterion for Retrieval-System Evaluation - An Empirical Inquiry into the User Evaluation", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 93-103

Suchi-T, "Defining Lymphoma - A Citation-Classic Commentary on Some Problems on the Histopathological Diagnosis of Non-Hodgkins Malignant-Lymphoma - A Proposal of a New Type by Suchi,T., Tajima,K., Nanba,K., Wakasa,H., Mikata,A., Kikucki,M., Mori,S., Watanabe,S., Mohri,N., Shamaoto,M., Harigaya,K., Itagaki,T., Matsuda,M., Kirino,Y., Takagi,K. and Fukunaga,S.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 22, pp 10-10

Sudell-AJ Horner-JS Jolly-U Pain-CH, "Length of Stay in General Medical Beds - Implications for the NHS White Paper of Variance Within One Performance Indicator", JOURNAL OF PUBLIC HEALTH MEDICINE,1991, Vol 13, Iss 2, pp 88-95

Sugden-D, "Funding UK Research - Comment on the Report to the Abrc from the Working Group on Peer-Review", AREA,1991, Vol 23, Iss 4, pp 368-371

Sumner-RG, "Utilizing the Age of References to Control the Exhaustivity of the Reference Representation in Information-Retrieval", INFORMATION PROCESSING & MANAGEMENT,1995, Vol 31, Iss 1, pp 29-45

Sundby-J Olsen-A Schei-B, "Quality of Care for Infertility Patients - An Evaluation of a Plan for a Hospital Investigation", SCANDINAVIAN JOURNAL OF SOCIAL MEDICINE,1994, Vol 22, Iss 2, pp 139-144

Suomi-R, "On the Nationality Balance of Authors and References in Selected MIS Journals", INFORMATION & MANAGEMENT,1993, Vol 24, Iss 6, pp 339-347

Supapol-AB Swierczek-FW, "The Role of Intellectual Property-Rights in Stimulating Commercialization in ASEAN - Lessons from Canada", TECHNOVATION,1994, Vol 14, Iss 3, pp 181-195

Sutherland-HJ Meslin-EM Dacunha-R Till-JE, "Judging Clinical Research Questions - What Criteria Are Used", SOCIAL SCIENCE & MEDICINE,1993, Vol 37, Iss 12, pp 1427-1430

Svec-F, "Citation Analysis and Impact Factor", CHEMICKE LISTY,1994, Vol 88, Iss 10, pp 672-673

Svoboda-J, "Chicken Tumorigenic Virus in Mammals - A Citation-Classic Commentary on the Tumorigenic Action of Rous-Sarcoma Virus in Rats and the Permanent Production of Rous Virus by the Induced Rat Sarcoma Xc by Svoboda,J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 4, pp 8-8

Svoboda-J, "Chicken Tumorigenic Virus in Mammals - A Citation-Classic Commentary on the Tumorigenic Action of Rous-Sarcoma Virus in Rats and the Permanent Production of Rous Virus by the Induced Rat Sarcoma Xc by Svoboda,J.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 4, pp 8-8

Svoboda-J, "Oncogenic Provirus Integration and Rescue - A Citation-Classic Commentary on Demonstration of the Absence of Infectious Rous Virus in Rat-Tumor Xc, Whose Structurally Intact-Cells Produce Rous-Sarcoma When Transferred to Chicks by Svoboda,J., Chyle,P., Simkovic,D. and Hilgert,I.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 4, pp 9-9

Swanbeck-G, "Treating Psoriasis with Guarded Enthusiasm - A Citation-Classic Commentary on Treatment of Psoriasis with Oral Psoralens and Longwave Ultraviolet-Light by Swanbeck,G., Thyresson-Hok,M., Bredberg,A., and Lambert,B.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 16, pp 8-8

Swanson-RW, "Psychological Issues in CPR", ANNALS OF EMERGENCY MEDICINE,1993, Vol 22, Iss 2, pp 350-353

Sweet-W, "French Science Observatory Issues 1st Volume of Science Indicators", PHYSICS TODAY,1991, Vol 44, Iss 12, pp 59-60

Sweetland-JH, "Peer-Review in Scientific Publishing, by Papers, From, The, 1st-International-Congress-On-Peer-Review-In-Biomedical-Publication", LIBRARY QUARTERLY,1992, Vol 62, Iss 3, pp 359-360

Sweitzer-BJ Cullen-DJ, "How Well Does a Journals Peer-Review

Process Function - A Survey of Authors Opinions", JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION,1994, Vol 272, Iss 2, pp 152-153

Sylvain-C, "Canadian Research Activity in Aquaculture - A Bibliometric Analysis", SCIENTOMETRICS,1993, Vol 27, Iss 3, pp 295-316

Symonds-EM, "Research Assessment - As Strange a Maze as Eer Men Trod - Report No-4, by J. Griffith", JOURNAL OF PUBLIC HEALTH MEDICINE 1995, Vol 17, Iss 4, pp 494-494

Symons-MCR, "Studies of Solvation Using Spectroscopy - A Citation-Classic Commentary on Solvation Spectra .1. The Effects of Environmental-Changes upon the Ultra-Violet Absorption of Solvated Iodide-Ions .2. The Nature of the Electronically Excited-State of Solvated Iodide-Ions by Smith,M., and Symons,M.C.R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 36, pp 9-9

Szavakovats-E, "Non-Indexed Eponymal Citedness (Niec) - 1st Fact-Finding Examination of a Phenomenon of Scientific Literature", JOURNAL OF INFORMATION SCIENCE,1994, Vol 20, Iss 1, pp 55-70

Sze-H, "Life and H+ Pumps - A Citation Commentary on H+-Translocating ATPases - Advances Using Membrane-Vesicles by Sze,H", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 18, pp 8-8

Sze-PY, "Problems with Peer-Review", TECHNOLOGY REVIEW,1992, Vol 95, Iss 2, pp 8-8

Szewczuk-A, "Basic Chemistry in Post-World-War-II Poland - A Citation-Classic Commentary on a New Method for Preparation of D-Glyceraldehyde-3-Phosphate - (Nowa Metoda Otrzymywania D-Gliceraldehydo-3-Fosforanu) by Szewczuk,A., Wolny,E., Wolny,M., and Baranowski,T.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 12, pp 10-10

Szklo-M, "Communication of Research Findings in Peer-Reviewed Journals - Publication Bias, Timing of Publication, Conflicting Interests and Fraud", SCIENCE OF THE TOTAL ENVIRONMENT 1996, Vol 184, Iss 1-2, pp 129-130

Szymanski-EM Leahy-MJ Linkowski-DC, "Reported Preparedness of Certified Counselors in Rehabilitation Counseling Knowledge Areas", REHABILITATION COUNSELING BULLETIN,1993, Vol 37, Iss 2, pp 146-162

Taguesutcliffe-J, "Modeling and Forecasting Contact Time as a Measure of Item Informativeness", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 259-267

Tahai-A Kelly-GW, "An Alternative View of Citation Patterns of Quantitative Literature Cited by Business and Economic Researchers", JOURNAL OF ECONOMIC EDUCATION 1996, Vol 27, Iss 3, pp 263+

Tainer-JA, "Science, Citation, and Funding", SCIENCE,1991, Vol 251, Iss 5000, pp 1408-1408

Tait-D, "Metaphor Wars in Evaluation Research - Reviewing Guardianship Boards in 2 States", JOURNAL OF LAW AND SOCIETY,1994, Vol 21, Iss 2, pp 238-252

Takagi-K Okabe-S, "A Simple Method for Producing Stress-Ulcers in the Rat - A Citation-Classic Commentary on the Effects of Drugs on the Production and Recovery Processes of the Stress-Ulcer by Takagi,K. and Okabe,S.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 10,

pp 10-10

Takahashi-K Hoshuyama-T Ikegami-K Itoh-T Higashi-T Okubo-T, "A Bibliometric Study of the Trend in Articles Related to Epidemiology Published in Occupational-Health Journals", OCCUPATIONAL AND ENVIRONMENTAL MEDICINE 1996, Vol 53, Iss 7, pp 433-438

Takyi-IK, "A Multidimensional Methodology for Evaluating Public Transportation Services", TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE,1993, Vol 27, Iss 5, pp 395-405

Talbott-SP, "Peer-Review Drives Compensation at Johnsonville", PERSONNEL JOURNAL,1994, Vol 73, Iss 10, pp 126-&

Tamarelli-AW, "Daubert V Merrell-Dow-Pharmaceuticals - Pushing the Limits of Scientific Reliability - The Questionable Wisdom of Abandoning the Peer-Review Standard for Admitting Expert Testimony", VANDERBILT LAW REVIEW,1994, Vol 47, Iss 4, pp 1175-1203

Tamir-P, "Science-Education Research Viewed Through Citation Indexes of Major Reviews", JOURNAL OF RESEARCH IN SCIENCE TEACHING 1996, Vol 33, Iss 7, pp 687-691

Tan-EM, "Lupus - A Need for Criteria - A Citation-Classic Commentary on the 1982 Revised Criteria for the Classification of Systemic Lupus-Erythematosus by Tan,E.M., Cohen,A.S., Fries,J.F., Masi,A.T., Mcshane,D.J., Rothfield,N.F., Schaller,J.G., Talal,N., Winchester,R.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 50, pp 9-9

Tansey-MJ, "Navigating the Information Matrix - Todays Technology Environment, Tomorrows Technology Requirements", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 27-CINF

Tarnowmordi-W Parry-G Gould-C Fowlie-P, "Crib and Performance Indicators for Neonatal Intensive-
Care Units (Nicus)", ARCHIVES OF DISEASE IN CHILDHOOD 1996, Vol 74, Iss 1, pp F79-F80

Tashjian-AH, "Hormone-Producing Cell-Culture Models - A Citation-Classic Commentary on Establishment of Clonal Strains of Rat Pituitary-Tumor Cells That Secrete Growth-Hormone by Tashjian,A.H., Yasumura,Y., Levine,L., Sato,G.H., and Parker,M.L., and on Thyrotropin-Releasing-Hormone - Direct Evidence for Stimulation of Prolactin Production by Pituitary-Cells in Culture - By Tashjian,A.H., Barowsky,N.J., and Jensen,D.K.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 26, pp 9-9

Taub-D, "The Woodward Synthesis - A Citation-Classic Commentary on the Total Synthesis of Steroids by Woodward,R.B., Sondheimer,F., Taub,D., Heusler,K., and Mclamore,W.M., and the Total Synthesis of a Steroid by Woodward,R.B., Sondheimer,F., Taub,D., Heusler,K., and Mclamore,W.M.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 14, pp 10-10

Taubes-G, "Citation Rankings - No Technical Knockout", SCIENCE,1993, Vol 260, Iss 5110, pp 885-885

Taubes-G, "Peer-Review Goes Under the Microscope", SCIENCE,1993, Vol 262, Iss 5130, pp 25-26

Taubes-G, "Physics Publishing - Peer-Review in Cyberspace", SCIENCE,1994, Vol 266, Iss 5187, pp 967-967

Tavernor-D, "Peer-Review", JOURNAL OF SMALL ANIMAL

PRACTICE,1992, Vol 33, Iss 9, pp 413-413

Taylor-A, "Reference Materials and Analytical Standards to Stimulate Improved Laboratory Performance - Experience from the External Quality Assessment Scheme for Trace-
Elements in Biological Samples", MIKROCHIMICA ACTA 1996, Vol 123, Iss 1-4, pp 251-260

Taylor-J, "A Statistical-Analysis of the ,1992 Research Assessment Exercise", JOURNAL OF THE ROYAL STATISTICAL SOCIETY SERIES A-STATISTICS IN SOCIETY,1995, Vol 158, Iss P2, pp 241-261

Taylor-J Johnes-J, "The CitationRecord of Regional Studies and Related Journals, 1980-89", REGIONAL STUDIES,1992, Vol 26, Iss 1, pp 93-97

Taylor-JW, "Chemists and Peer-Review - Implications for Teaching and Learning from the Aahe Peer-Review of Teaching Project", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 1996, Vol 212, Iss AUG, pp 8-CHED

Teferra-D, "The Status and Capacity of Science Publishing in Africa", JOURNAL OF SCHOLARLY PUBLISHING 1995, Vol 27, Iss 1, pp 28-36

Teichler-U, "Evaluation of the EC Training Fellowship Program Based on a Fellows Questionnaire Survey", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 343-365

Teitel-S, "Patents, Research-and-Development Expenditures, Country Size, and per-Capita Income - An International Comparison", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 137-159

Testa-B Jenner-P, "The Multifaceted Inhibition of Cytochrome-P-450 - A Citation-Classic Commentary on Inhibitors of Cytochrome-P-450S and Their Mechanism of Action by Testa,B, and Jenner,P", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 14, pp 10-10

Thacker-JRM, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 184-184

Thanassoulis-E Boussofiane-A Dyson-RG, "A Comparison of Data Envelopment Analysis and Ratio Analysis as Tools for Performance Assessment", OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE 1996, Vol 24, Iss 3, pp 229-244

Theander-O Aman-P, "Informative Analysis of Dietary Fiber - A Citation-Classic Commentary on Studies on Dietary-Fibers .1. Analysis and Chemical Characterization of Water-Soluble and Water-Insoluble Dietary-Fibers by Theander,O. and Aman,P.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 10, pp 10-10

Thirtle-C, "Science Under Scarcity - Principles and Practice for Agricultural-Research Evaluation and Priority Setting, by J.M. Alston, G.W. Norton, P.G. Pardey", EUROPEAN REVIEW OF AGRICULTURAL ECONOMICS 1996, Vol 23, Iss 3, pp 371-373

Thoma-E Tribiahn-R, "Recent Developments in Patent Databases", NACHRICHTEN FUR DOKUMENTATION 1995, Vol 46, Iss 6, pp 331-340

Thomas-J, "Graduate Student Use of Journals - A Bibliometric Study of Psychology Theses", BEHAVIORAL & SOCIAL SCIENCES LIBRARIAN,1993, Vol 12, Iss 1, pp 1-7

Thomas-JW, "Does Risk-Adjusted Readmission Rate Provide Valid Information on Hospital Quality", INQUIRY-THE JOURNAL OF HEALTH CARE

ORGANIZATION PROVISION AND FINANCING 1996, Vol 33, Iss 3, pp 258-270

Thomas-JW Holloway-JJ Guire-KE, "Validating Risk-Adjusted Mortality as an Indicator for Quality of Care", INQUIRY-THE JOURNAL OF HEALTH CARE ORGANIZATION PROVISION AND FINANCING,1993, Vol 30, Iss 1, pp 6-22

Thomas-KS, "The Development of Eponymy - A Case-Study of the Southern Blot", SCIENTOMETRICS,1992, Vol 24, Iss 3, pp 405-417

Thomas-P Kearney-G Napier-E Ellis-E Leudar-I Johnston-M, "The Reliability and Characteristics of the Brief Syntactic Analysis", BRITISH JOURNAL OF PSYCHIATRY 1996, Vol 168, Iss 3, pp 334-337

Thomas-SM, "The Evaluation of Plant Biomass Research - A Case-Studyof the Problems Inherent in Bibliometric Indicators", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 149-167

Thompson-AP Lake-K Rickards-C, "Frequently Cited Sources in Human Sexology - A Nineties Update", JOURNAL OF SEX & MARITAL THERAPY,1994, Vol 20, Iss 3, pp 229-236

Thompson-B Daniel-LG, "Seminal Readings on Reliability and Validity - A Hit Parade Bibliography", EDUCATIONAL AND PSYCHOLOGICAL MEASUREMENT 1996, Vol 56, Iss 5, pp 741-745

Thompson-GR, "Frequency of Citation and Outcome of Cholesterol Lowering Trials", BRITISH MEDICAL JOURNAL,1992, Vol 305, Iss 6850, pp 422-422

Thompson-I, "Qualitative Evaluation and Research Methods, 2nd Edition, by M.Q. Patton", JOURNAL OF TECHNICAL WRITING AND COMMUNICATION,1992, Vol 22, Iss 1, pp 115-116

Thorn-S, "Espere - Electronic Submission and Peer-Review", LEARNED PUBLISHING 1996, Vol 9, Iss 3, pp 131-132

Thyer-BA, "The Enduring Intellectual Legacy of Skinner,B.F. - A Citation Count from 1966-1989", BEHAVIOR ANALYST,1991, Vol 14, Iss 1, pp 73-75

Tickamyer-AR, "Sex, Lies, and Statistics - Can Rural Sociology Survive Restructuring - (Or) What Is Right with Rural Sociology and How Can We Fix It", RURAL SOCIOLOGY 1996, Vol 61, Iss 1, pp 5-24

Tien-FF Blackburn-RT, "Faculty Rank System, Research Motivation, and Faculty Research Productivity - Measure Refinement and Theory Testing", JOURNAL OF HIGHER EDUCATION 1996, Vol 67, Iss 1, pp 2+

Tien-JM Uichanco-CCN, "IEEE Transactions on Systems, Man, and Cybernetics - Bibliographic Analysis and Policy Considerations", IEEE TRANSACTIONS ON SYSTEMS MAN AND CYBERNETICS,1992, Vol 22, Iss 6, pp 1245-1259

Tierney-AJ, "An Analysis of Nursings Performance in the ,1992 Assessment of Research in British Universities", JOURNAL OF ADVANCED NURSING,1994, Vol 19, Iss 3, pp 593-602

Tijssen-RJW, "A Scientometric Cognitive Study of Neural-Network Research - Expert Mental Maps Versus Bibliometric Maps", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 111-136

Tijssen-RJW Vanraan-AFJ, "Mapping Changes in Science and Technology - Bibliometric Cooccurrence Analysis of the R-and-D Literature", EVALUATION REVIEW,1994, Vol 18, Iss 1, pp 98-115

Tiles-M, "The Normal and Pathological - The Concept of a

Scientific Medicine", BRITISH JOURNAL FOR THE PHILOSOPHY OF SCIENCE,1993, Vol 44, Iss 4, pp 729-742

Tillotson-J, "Fan Mail for Citation Searching Article", DATABASE-THE MAGAZINE OF DATABASE REFERENCE AND REVIEW,1993, Vol 16, Iss 5, pp 6-6

Tjourmas-R, "Research Productivity and Perceived Prestige of Professional Journals - An Examination of Faculty Specializing in Public Librarianship", SERIALS LIBRARIAN,1994, Vol 25, Iss 1-2, pp 65-81

Tobin-EM Silverthorne-J, "Turning on Genes with Light - A Citation-Classic Commentary on Light-Regulation of Gene-Expression in Higher-Plants by Tobin,E.M. and Silverthorne,J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 10, pp 8-8

Todd-MM Warner-DS, "On the Importance of Inaccurate Bibliographic Citations", ANESTHESIOLOGY,1993, Vol 78, Iss 3, pp 615-615

Todorov-R, "Displaying Content of Scientific Journals - A CO-Heading Analysis", SCIENTOMETRICS,1992, Vol 23, Iss 2, pp 319-334

Todorov-R, "Facts or Imposed Names on Facts", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 461-464

Todorov-R Winterhager-M, "An Overview of Moravcsik,Mike Publication Activity in Physics", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 163-172

Tognolini-J Adams-K Hattie-J, "A Methodology to Choose Performance Indicators of Research Attainment in Universities", AUSTRALIAN JOURNAL OF EDUCATION,1994, Vol 38, Iss 2, pp 105-117

Tomaiuolo-NG Trolley-J, "Science-Citation-Index/Science-Citation-Index with Abstracts on Cd-ROM (Reprinted from Cd-ROM-Librarian, Vol 7, Pg 34, 2 ,1992)", CURRENT CONTENTS,1993, Vol 7, Iss FEB, pp 7-12

Tomov-DT, "Bibliometric Analysis of Internationalization of Modern Interdisciplinary Science", NAUCHNO-TEKHNICHESKAYA INFORMATSIYA SERIYA 1-ORGANIZATSIYA I METODIKA INFORMATSIONNOI RABOTY,1993, Iss 10, pp 30-32

Tomov-DT Mutafov-HG, "Comparative Indicators of Interdisciplinarity in Modern Science", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 267-278

Toni-F Velho-L, "The French Presence at Instituto-Nacional-de-Pesquisas-da-Amazonia-Inpa", INTERCIENCIA 1996, Vol 21, Iss 1, pp 25+

Toren-N, "Professional-Support and Intellectual-Influence Networks of Russian Immigrant Scientists in Israel", SOCIAL STUDIES OF SCIENCE,1994, Vol 24, Iss 4, pp 725-743

Tornquist-KM Hoenack-SA, "Firm Utilization of University Scientific-Research", RESEARCH IN HIGHER EDUCATION 1996, Vol 37, Iss 5, pp 509-534

Toutkoushian-RK, "Using Citations to Measure Sex-Discrimination in Faculty Salaries", REVIEW OF HIGHER EDUCATION,1994, Vol 18, Iss 1, pp 61-82

Tracey-JM, "Peer-Review .2. The Influence of Internal and External Standards on Outcome", NEW ZEALAND MEDICAL JOURNAL,1991, Vol

104, Iss 906, pp 66-67
Tracey-JM, "Peer-Review .2. The Influence of Internal and External Standards on Outcome", NEW ZEALAND MEDICAL JOURNAL,1991, Vol 104, Iss 906, pp 66-67
Tracey-JM, "Peer-Review .1. Attitudes to Internal and External Standards", NEW ZEALAND MEDICAL JOURNAL,1991, Vol 104, Iss 904, pp 8-10
TRANSP-R-A, "Toward a Comprehensive Understanding of Rideshare Promotion - The Use of Evaluation Research, by T.A. Horan", TRANSPORTATION RESEARCH PART A-GENERAL,1991, Vol 25, Iss 1, pp 64-65
Travis-GDL Collins-HM, "New Light on Old Boys - Cognitive and Institutional Particularism in the Peer-Review System", SCIENCE TECHNOLOGY & HUMAN VALUES,1991, Vol 16, Iss 3, pp 322-341
Traxler-G, "Research and Productivity in Asian Agriculture, by R.E. Evenson, C.E. Pray", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 74, Iss 4, pp 1049-1051
Traxler-G Byerlee-D Jain-KBL, "Downsizing of Agricultural-Research - Incorporating Scale Economies and Spillovers into Research Evaluation", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 1995, Vol 77, Iss 5, pp 1364-1364
Treloar-A, "Electronic Scholarly Publishing and the World-Wide-Web", JOURNAL OF SCHOLARLY PUBLISHING 1996, Vol 27, Iss 3, pp 135-150
Tremblay-PF King-PR Baines-GR, "Clinical and Demographic Characteristics of Voluntary and Involuntary Psychiatric-Inpatients", CANADIAN JOURNAL OF PSYCHIATRY-REVUE CANADIENNE DE PSYCHIATRIE,1994, Vol 39, Iss 5, pp 297-299
Trenchard-PM, "Hierarchical Bibliometry - A New Objective-Measure of Individual Scientific Performance to Replace Publication Counts and to Complement Citation Measures", JOURNAL OF INFORMATION SCIENCE,1992, Vol 18, Iss 1, pp 69-75
Trenerry-MR, "Neuropsychologic Assessment in Surgical-Treatment of Epilepsy", MAYO CLINIC PROCEEDINGS 1996, Vol 71, Iss 12, pp 1196-1200
Trimble-V, "Long-Term Careers of Astronomers with Doctoral Degrees from Prestigious vs Non-Prestigious Universities", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 71-77
Trimble-V, "Patterns in Citations to Papers by British Astronomers", QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY,1993, Vol 34, Iss 3, pp 301-314
Trimble-V, "Patterns in Citations of Papers by American Astronomers", QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY,1993, Vol 34, Iss 2, pp 235-250
Trimble-V, "Productivity and Impact of Large Optical Telescopes", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 237-246
Tripp-MR, "How Do Invertebrates Recognize Foreignness - A Citation-Classic Commentary on Hemagglutinin in the Blood of the Oyster, Crassostrea-Virginica by Tripp,M.R.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 26, pp 8-8
Trojanowski-T Rabow-I Rabow-L, "Neurosurgical Publications in European Journals", ACTA NEUROCHIRURGICA,1992, Vol 116, Iss 2-4, pp

98-106

Tronni-C Welebob-E, "End-User Satisfaction of a Patient Education Tool Manual Versus Computer-Generated Tool", COMPUTERS IN NURSING 1996, Vol 14, Iss 4, pp 235-238

Trost-BM, "Synthetic Dehydrogenation of Carbonyl and Related-Compounds - A Citation-Classic Commentary on New Synthetic Reaction - Sulfenylations and Dehydrosulfenylations of Esters and Ketones byTrost,B.M., Salzmann,T.Z., and Hiroi,L.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 30, pp 11-11

Trzepacz-PT, "A Review of Delirium Assessment Instruments", GENERAL HOSPITAL PSYCHIATRY,1994, Vol 16, Iss 6, pp 397-405

Tsipouri-LJ, "Effects of EC Research-and-Development Policy on Greece -Some Thoughts in View of the Stride Program", SCIENTOMETRICS,1991, Vol 21, Iss 3, pp 403-416

Tsou-K, "The Central Gray and Morphine Analgesia - A Citation-Classic Commentary on Studies on the Site of Analgesic Action of Morphine by Intracerebral Microinjection by Tsou,K., and Jang,C.S.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 30, pp 11-11

Tucker-DJ, "Eclecticism Is Not a Free Good - Barriers to Knowledge Development in Social-Work", SOCIAL SERVICE REVIEW 1996, Vol 70, Iss 3, pp 400-434

Tufte-ER, "Statistical Graphics and Self-Publishing - A Citation-Classic Commentary on the Visual-Display of Quantitative Information by Cheshire,C.T.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1992, Iss 50, pp 8-8

Tulchinskiy-MR, "Scientometric Analysis of the Development of Sociology in the Early 1990s (Using the Inion Bibliographic Database)", SOTSIOLOGICHESKIE ISSLEDOVANIYA,1994, Iss 6, pp 96-107

Tuohy-WS, "Characterizing the San-Francisco Estuary - A Case-Study of Science Management in the National Estuary Program", COASTAL MANAGEMENT,1993, Vol 21, Iss 2, pp 113-129

Turecki-G Rouleau-GA Mari-JJ Morgan-K, "A Systematic Evaluation of Linkage Studies in Bipolar Disorder", ACTA PSYCHIATRICA SCANDINAVICA 1996, Vol 93, Iss 5, pp 317-326

Turner-WA, "An Introduction to Scientometrics in France", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 5-8

Turner-WA, "Whats in an R - Infometrics or Informetrics", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 471-480

Turner-WA Lelu-A Georgel-A, "Geode - Optimizing Data-Flow Representation Techniques in a Network Information-System", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 269-281

Turner-WA Rojouan-F, "Evaluating Input Output Relationships in a Regional Research Network Using Co-Word Analysis", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 139-154

Turpin-RS Darcy-LA Koss-R Mcmahill-C Meyne-K Morton-D Rodriguez-J Schmaltz-S Schyve-P Smith-P, "A Model to Assess the Usefulness of Performance Indicators", INTERNATIONAL JOURNAL FOR QUALITY IN HEALTH CARE 1996, Vol 8, Iss 4, pp 321-329

Tuss-P, "From Student to Scientist - An Experiential Approach to Science-Education", SCIENCE COMMUNICATION 1996, Vol 17, Iss 4, pp 443-481

Twentyman-P Selby-P, "The Process of Peer-Review", BRITISH

JOURNAL OF CANCER,1991, Vol 63, Iss 2, pp 168-170

Tyrer-P, "Chairmans Action - The Importance of Executive Decisions in Peer-Review", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 164-164

Tyteca-D, "On the Measurement of the Environmental Performance of Firms - A Literature-Review and a Productive Efficiency Perspective", JOURNAL OF ENVIRONMENTAL MANAGEMENT 1996, Vol 46, Iss 3, pp 281-308

Tziner-A Reid-A Dolan-S, "Assessment-Centers - Critical-Review of Some Fundamental Themes", CANADIAN PSYCHOLOGY-PSYCHOLOGIE CANADIENNE,1993, Vol 34, Iss 1, pp 110-120

Ugolini-D Casilli-C Villa-D, "Authors Offprint Requests in Oncology Journals - At What Cost", JOURNAL OF EXPERIMENTAL & CLINICAL CANCER RESEARCH 1996, Vol 15, Iss 3, pp 301-305

Ullrich-A, "Molecules That Generate Biological Signals - A Citation-Classic Commentary on Rat Insulin Genes - Construction of Plasmids Containing the Coding Sequences by Ullrich,A. Et-Al and Human Epidermal Growth-Factor Receptor cDNA Sequence and Aberrant Expression of the Amplified Gene in A431 Epidermoid Carcinoma-Cells by Ullrich,A. Et-Al and Human Insulin-Receptor and Its Relationship to the Tyrosine Kinase Family of Oncogenes by Ullrich,A. Et-Al", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 28, pp 9-10

Unsworth-JM, "Problems and Possibilities in the Networked Publication of Peer-Reviewed Scholarly Research", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1992, Vol 203, Iss APR, pp 29-CINF

Updegraff-KA Mchale-SM Crouter-AC, "Gender-Roles in Marriage - What Do They Mean for Girls and Boys School-Achievement", JOURNAL OF YOUTH AND ADOLESCENCE 1996, Vol 25, Iss 1, pp 73-88

Urban-D, "Quantitative Measurement of Public Opinions on New Technologies - An Application of SEM-Methodology to the Analysis of Beliefs and Values Toward New Human Applications of Genetic-Engineering", SCIENTOMETRICS 1996, Vol 35, Iss 1, pp 71-92

Ushizawa-N, "Concept Symbolization of Cited Document - An Analysis on Medical Journal Articles", LIBRARY AND INFORMATION SCIENCE,1992, Iss 30, pp 133-146

Uzun-A, "A Bibliometric Analysis of Physics Publications from Middle-Eastern Countries", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 259-269

Uzun-A Menard-A Ozel-ME, "Citation Status of Turkish Physics Publications in Foreign-Journals - A Global Analysis", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 79-87

Uzun-A Ozel-ME, "Publication Patterns of Turkish Astronomers", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 159-169

Vahlensieck-M, "Bibliography Database with Variable Formatting Capacity", RADIOLOGE,1992, Vol 32, Iss 5, pp 255-257

Vaillant-GE, "The Development of Defense-Mechanisms - Theory, Research, and Assessment, by P. Cramer", CONTEMPORARY PSYCHOLOGY,1992, Vol 37, Iss 1, pp 13-14

Vala-J Lima-ML Caetano-A, "Mapping European Social-Psychology - Co-Word Analysis of the Communications at the 10th General-Meeting of the Eaesp", EUROPEAN JOURNAL OF SOCIAL PSYCHOLOGY 1996, Vol 26, Iss 5, pp 845-850

Vanborm-J, "From Interlibrary Lending Statistics to Clearinghouse - The Use of Ill Statistics in Belgium", SCIENTOMETRICS,1992, Vol 25, Iss 1, pp 89-100

Vanchieri-C, "Peer-Review Put to the Test - Credibility at Stake", JOURNAL OF THE NATIONAL CANCER INSTITUTE,1993, Vol 85, Iss 20, pp 1632-1633

Vandamme-F, "On Bibliometrics As an Evaluative Tool for Scientists", COMMUNICATION AND COGNITION1990, Vol 23, Iss 4, pp 317-321

Vandekaa-DJ, "Picking the Winners by Consensus - Grant-Giving Practice in the Netherlands", HIGHER EDUCATION,1994, Vol 28, Iss 1, pp 59-83

Vandenbesselaar-P Leydesdorff-L, "Mapping Change in Scientific Specialties - A Scientometric Reconstruction of the Development of Artificial-Intelligence", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE 1996, Vol 47, Iss 6, pp 415-436

Vandenbos-A, "For the Fun of It - A Citation-Classic Commentary on Alternative Interpretation of Maximum-Entropy Spectral-Analysis by Vandenbos,A.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1992, Iss 44, pp 10-10

Vandenbroucke-JP, "Can the Quality of Peer-Review Be Measured - Comment", JOURNAL OF CLINICAL EPIDEMIOLOGY,1994, Vol 47, Iss 7, pp 821-822

Vanderkruit-PC, "A Comparison of Astronomy in 15 Member Countries of the Organization for Economic Cooperation and Development", SCIENTOMETRICS,1994, Vol 31, Iss 2, pp 155-172

Vanfleet-C, "Evidence of Communication Among Public Librarians and Library and Information-Science Educators in Public-Library Journal Literature", LIBRARY & INFORMATION SCIENCE RESEARCH,1993, Vol 15, Iss 3, pp 257-274

Vanhaaster-I Lesage-AD Cyr-M Toupin-J, "Problems and Needs for Care of Patients Suffering from Severe Mental-Illness", SOCIAL PSYCHIATRY AND PSYCHIATRIC EPIDEMIOLOGY,1994, Vol 29, Iss 3, pp 141-148

Vanhemel-OJS Elferinkstinkens-PM Brand-R, "How to Compare and Report Department Specific Mortality-Rates for Peer-Review Using the Perinatal Database of the Netherlands", EUROPEAN JOURNAL OF OBSTETRICS GYNECOLOGY AND REPRODUCTIVE BIOLOGY,1994, Vol 56, Iss 1, pp 1-7

Vanhooydonk-G, "Cost and Citation Data for 5399 Scientific Journals in Connection with Journal Price-Setting, Copyright Laws and the Use of Bibliometric Data for Project Review", SERIALS LIBRARIAN 1995, Vol 27, Iss 1, pp 45-58

Vanhooydonk-G Gevaert-R Milisproost-G Vandesompel-H Debackere-K, "A Bibliotheconomic Analysis of the Impact Factors of Scientific Disciplines", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 65-81

Vanijzendoorn-MH Schuengel-C, "The Measurement of Dissociation in Normal and Clinical Populations - Metaanalytic Validation of the Dissociative Experiences Scale (Des)", CLINICAL PSYCHOLOGY REVIEW 1996, Vol 16, Iss 5, pp 365-382

Vanleeuwen-TN Tijssen-RJW, "Assessing Multidisciplinary Areas of Science and Technology - A Synthetic Bibliometric Study of Dutch

Nuclear-Energy Research", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 115-133

Vanoers-JAM Reelick-NF, "Quantitative Indicators for a Healthy City - The Rotterdam Local Health Information-System", JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH,1992, Vol 46, Iss 3, pp 293-296

Vanraan-AFJ, "Fractal Geometry of Information Space As Represented by Co-Citation-Clustering", SCIENTOMETRICS,1991, Vol 20, Iss 3, pp 439-449

Vanraan-AFJ, "Introduction to the Proceedings of the 4th International-Conference on Science and Technology Indicators", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 191-193

Vanraan-AFJ, "Little Scientometrics, Big Scientometrics ... and Beyond", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 529-531

Vanraan-AFJ, "Self-Organized Mapping of Science and Technology - The Application of Bibliometric Cartography", ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY,1994, Vol 208, Iss AUG, pp 3-CINF

Vanraan-AFJ Tijssen-RJW, "The Neural Net of Neural Network Research - An Exercise in Bibliometric Mapping", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 169-192

Vansoest-PJ, "Fiber in the Diets of Animals and Man - A Citation-Classic Commentary on Use of Detergents in the Analysis of Fibrous Feeds .4. Determination of Plant Cell-Wall Constituents by Vansoest,P.J. and Wine,R.H. and Development of a Comprehensive System of Feed Analyses and Its Application to Forages and Nutritional Ecology of the Ruminant by Vansoest,P.J.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 26, pp 8-8

Vanthof-S Nicolson-M, "The Rise and Fall of a Fact - The Increase in Anorexia-Nervosa", SOCIOLOGY OF HEALTH & ILLNESS 1996, Vol 18, Iss 5, pp 581-608

Vantuijl-HFJM, "The Application of a Performance Management-System in Hospitals - A Hypothetical Example", WORK AND STRESS,1992, Vol 6, Iss 3, pp 311-326

Vasil-L, "Gender Differences in the Academic Career in New-Zealand Universities", NEW ZEALAND JOURNAL OF EDUCATIONAL STUDIES,1993, Vol 28, Iss 2, pp 143-153

Vasil-L, "Social-Process Skills and Career Achievement Among Male and Female Academics", JOURNAL OF HIGHER EDUCATION 1996, Vol 67, Iss 1, pp 103+

Veggeberg-S, "CitationRecords Underscore Nobel Winners Long-Standing Influence on Lab Research - For Most of Them, Their Prizewinning Work Has Been Referenced Hundreds of Times by Their Peers", SCIENTIST,1992, Vol 6, Iss 24, pp 1+

Veith-GD, "The Black Magic of Chemical Residues - A Citation-Classic Commentary on Measuring and Estimating the Bioconcentration Factor in Fish by Veith,G.D., Defoe,D.L., and Bergstedt,B.V.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 34, pp 8-8

Vener-KJ Feuer-EJ Gorelic-L, "A Statistical-Model Validating Triage for the Peer-Review Process - Keeping the Competitive Applications in the Review Pipeline", FASEB JOURNAL,1993, Vol 7, Iss 14, pp 1312-1319

Verbeek-JHAM Hulshof-CTJ Vandijk-FJH Kroon-PJ, "Evaluation of an Occupational-Health Care Program - Negative Results, Positive Results or a Failure", OCCUPATIONAL MEDICINE-OXFORD,1993, Vol 43, Iss S1, pp S34-S37

Vernon-DTA Blake-RL, "Does Problem-Based Learning Work - A Metaanalysis of Evaluative Research", ACADEMIC MEDICINE,1993, Vol 68, Iss 7, pp 550-563

Verstegen-JAAM Huirne-RBM Dijkhuizen-AA Kleijnen-JPC, "Economic Value of Management-Information-Systems in Agriculture - A Review of Evaluation Approaches", COMPUTERS AND ELECTRONICS IN AGRICULTURE 1995, Vol 13, Iss 4, pp 273-288

Vicente-KJ Brewer-WF, "Reconstructive Remembering of the Scientific Literature", COGNITION,1993, Vol 46, Iss 2, pp 101-128

Vidal-EQ Linares-MJP Vera-JA Sanchez-MV, "Contributions to the Study of Cuban Psychology and Psychiatry - A Bibliometric Analysis of the Revista-Del-Hospital-Psiquiatrico-de-La-Habana", REVISTA LATINOAMERICANA DE PSICOLOGIA1990, Vol 22, Iss 3, pp 343-356

Vilkas-C, "Scientific Assessments and Collective Decisions - The Comite National de La Recherche Scientifique", SOCIOLOGIE DU TRAVAIL 1996, Vol 38, Iss 3, pp 331+

Vincent-RC, "Telecommunications Research Productivity of United-States Communication Programs - 1984-1989", JOURNALISM QUARTERLY,1991, Vol 68, Iss 4, pp 840-851

Vinkler-P, "Magic Triangle for 3 Relative Impact Indicators", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 143-146

Vinkler-P, "Model of Manifested Communication Through Publications", SCIENTOMETRICS,1994, Vol 31, Iss 3, pp 223-239

Vinkler-P, "Model for Quantitative Selection of Relative Scientometric Impact Indicators", SCIENTOMETRICS 1996, Vol 36, Iss 2, pp 223-236

Vinkler-P, "Percentage Patent Representation (Ppr) Bilateral Patent Balance (Bpb) and Patent Dominancy (Pd) Indicators Characterizing International Patenting Relations", SCIENTOMETRICS,1993, Vol 27, Iss 1, pp 97-103

Vinkler-P, "Possible Causes of Differences in Information Impact of Journals from Different Subfields", SCIENTOMETRICS,1991, Vol 20, Iss 1, pp 145-161

Vinkler-P, "Relationships Between the Rate of Scientific Development and Citations - The Chance for Citedness Model", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 375-386

Vinkler-P, "Research Contribution, Authorship and Team Cooperativeness", SCIENTOMETRICS,1993, Vol 26, Iss 1, pp 213-230

Vinkler-P, "Some Aspects of the Evaluation of Scientific and Related Performances of Individuals", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 109-116

Vinkler-P, "Some Practical Aspects of the Standardization of Scientometric Indicators", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 237-245

Vinkler-P, "The Origin and Features of Information Referenced in Pharmaceutical Patents", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 283-302

Vinkler-P, "Words and Indicators - As Scientometrics Stands",

SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 495-504

Vinuela-E, "From Golf-Courses to Protein Labs - A Citation-Classic Commentary on Molecular-Weight Estimation of Polypeptide-Chains by Electrophoresis in SDS-Polyacrylamide Gels by Shapiro,A.L., Vinuela,E. and Maizel,J.V.", CURRENT CONTENTS/LIFE SCIENCES,1991, Iss 6, pp 10-10

Vlachy-J, "Scientometrics - What to Do", SCIENTOMETRICS,1994, Vol 30, Iss 2-3, pp 521-527

Volkwein-JF Carbone-DA, "The Impact of Departmental Research and Teaching Climates on Undergraduate Growth and Satisfaction", JOURNAL OF HIGHER EDUCATION,1994, Vol 65, Iss 2, pp 147-167

Vonborstel-RC, "An Analysis of Citation Analysis", SCIENCE,1991, Vol 251, Iss 5001, pp 1546-1546

Vonweizsacker-RK, "Distributive Implications of an Aging Society", EUROPEAN ECONOMIC REVIEW 1996, Vol 40, Iss 3-5, pp 729-746

Voon-JP, "Measuring Research Benefits from a Reduction of Pale, Soft and Exudative Pork in Australia", JOURNAL OF AGRICULTURAL ECONOMICS,1991, Vol 42, Iss 2, pp 180-184

Voon-JP Edwards-GW, "The Calculation of Research Benefits with Linear and Nonlinear Specifications of Demand and Supply Functions", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1991, Vol 73, Iss 2, pp 415-420

Voon-TJ, "Measuring Research Benefits in an Imperfect Market", AGRICULTURAL ECONOMICS,1994, Vol 10, Iss 1, pp 89-93

Voon-TJ, "The Gains from Agricultural-Research Under Distorted Trade - Comments", JOURNAL OF PUBLIC ECONOMICS 1996, Vol 59, Iss 2, pp 309-311

Voon-TJ Edwards-GW, "Research Payoff from Quality Improvement - The Case of Protein in Australian Wheat", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 74, Iss 3, pp 564-572

Voon-TJP, "A Cross-Commodity Appraisal of Demand-Raising Research Benefits - Pork and Chicken in Australia", JOURNAL OF AGRICULTURAL ECONOMICS,1992, Vol 43, Iss 2, pp 243-247

Voss-EG, "Literature Citations", BIOSCIENCE,1994, Vol 44, Iss 4, pp 210-210

Voss-HG, "Aamerican-Association-of-Physics-Teachers - Citations for Distinguished Service, 1996 - Rossing,Thomas,D", AMERICAN JOURNAL OF PHYSICS 1996, Vol 64, Iss 8, pp 972-973

Vourlekis-BS Bakkefriedland-K Zlotnik-JL, "Clinical Indicators to Assess the Quality of Social-Work Services in Nursing-Homes", SOCIAL WORK IN HEALTH CARE 1995, Vol 22, Iss 1, pp 81-93

Wagner-EE Young-GR Patty-CE, "Sequential Optimum Selection - A Categorical Alternative to Discriminant-Analysis for Conducting Research in Assessment", PERCEPTUAL AND MOTOR SKILLS,1994, Vol 79, Iss 1, pp 375-383

Wagnerdobler-R, "Citations of Legal Decisions in Legal Data-Bases - Proposal of 2 New Methods for Information-Retrieval in the Legal Field", NACHRICHTEN FUR DOKUMENTATION,1994, Vol 45, Iss 5, pp 279-290

Wagnerdobler-R, "The Frequency-Distribution of Legal Decision Citations in the German Jurisdiction", SCIENTOMETRICS,1994, Vol 29, Iss 1, pp 15-26

Wagnerdobler-R, "Were Has the Cumulative Advantage Gone - Some Observations About the Frequency-Distribution of Scientific Productivity, of Duration of Scientific Participation, and of Speed of Publication", SCIENTOMETRICS,1995, Vol 32, Iss 2, pp 123-132

Wagnerdobler-R Berg-J, "The Dependence of Lotkas Law on the Selection of Time Periods in the Development of Scientific Areas and Authors", JOURNAL OF DOCUMENTATION,1995, Vol 51, Iss 1, pp 28-43

Wagnerdobler-R Berg-J, "Regularity and Irregularity in the Development of Scientific Disciplines - The Case of Mathematical Logic", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 303-319

Wagnerdobler-R Berg-J, "19th-Century Mathematics in the Mirror of Its Literature - A Quantitative Approach", HISTORIA MATHEMATICA 1996, Vol 23, Iss 3, pp 288-318

Wait-JR, "Terrestrial Electromagnetics Explored - A Citation-Classic Commentary on Electromagnetic-Waves in Stratified Media by Wait,J.R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 22, pp 11-11

Waite-VS Walker-R, "Medical and Surgical Peer-Review", AMERICAN JOURNAL OF SURGERY,1994, Vol 168, Iss 1, pp 1-1

Walden-B Fineman-C Monroe-WS Parrine-MJ, "Western-European Political-Science - An Acquisition Study", COLLEGE & RESEARCH LIBRARIES,1994, Vol 55, Iss 4, pp 286-297

Walker-BH, "Assessing Scientific Performance", SEARCH,1991, Vol 22, Iss 2, pp 62-64

Walker-F, "Research Assessment Exercise", JOURNAL OF PATHOLOGY,1992, Vol 168, Iss S, pp A148-A148

Walker-IR Smol-JP Engstrom-DR Birks-HJB, "An Assessment of Chironomidae As Quantitative Indicators of Past Climatic-Change", CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES,1991, Vol 48, Iss 6, pp 975-987

Walker-PL, "Carbon Gasification Is Ubiquitous - A Citation-Classic Commentary on Gas Reactions of Carbon by Walker,P.L., Rusinko,F. and Austin,I.G.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1991, Iss 4, pp 8-8

Wallace-WA, "Peer-Review Filings and Their Implications in Evaluating Self-Regulation", AUDITING-A JOURNAL OF PRACTICE & THEORY,1991, Vol 10, Iss 1, pp 53-68

Walsh-P, "Finding Key Performance Drivers - Some New Tools", TOTAL QUALITY MANAGEMENT 1996, Vol 7, Iss 5, pp 509-519

Wang-BC Li-D, "Retrieving an Article from Erroneous Citation", ANESTHESIA AND ANALGESIA,1993, Vol 76, Iss 3, pp 671-671

Wang-P Soergel-D, "Beyond Topical Relevance - Document Selection Behavior of Real Users of Ir Systems", PROCEEDINGS OF THE ASIS ANNUAL MEETING,1993, Vol 30, pp 87-92

Wang-PL White-MD, "A Qualitative Study of Scholars Citation Behavior", PROCEEDINGS OF THE ASIS ANNUAL MEETING 1996, Vol 33, pp 255-261

Ward-H, "Game-Theory and the Politics of the Global Commons", JOURNAL OF CONFLICT RESOLUTION,1993, Vol 37, Iss 2, pp 203-235

Wareham-V Bain-C Cruickshank-D, "Cesarean-Section Audit by Peer-Review", EUROPEAN JOURNAL OF OBSTETRICS GYNECOLOGY AND REPRODUCTIVE BIOLOGY,1993, Vol 48, Iss 1, pp 9-14

Warnes-AM, "Being Old, Old-People and the Burdens of Burden", AGEING AND SOCIETY,1993, Vol 13, Iss SEP, pp 297-338

Warren-KS, "Peer-Review Study", SCIENCE,1994, Vol.266, Iss 5187, pp 954-954

Warren-KS, "The Start of a Global Health Strategy - A Citation-Classic Commentary on Selective Primary Health-Care - An Interim Strategy for Disease-Control in Developing-Countries by Walsh,J.A., Warren,K.S.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 50, pp 11-11

Wasserman-GS, "Do Peer Reviewers Really Agree More on Rejections Than Acceptances - A Random-Agreement Benchmark Says They Do Not", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1, pp 165-165

Wasserman-I Stack-S, "The Effect of Religion on Suicide - An Analysis of Cultural-Context", OMEGA-JOURNAL OF DEATH AND DYING,1993, Vol 27, Iss 4, pp 295-305

Waterfield-MD, "An Oncogene Can Function as a Growth-Factor - A Citation-Classic Commentary on Platelet-Derived Growth-Factor Is Structurally Related to the Putative Transforming Protein P28(SIS) of Simian Sarcoma-Virus by Waterfield,M.D., Scrace,G.T., Whittle,N., Stroobant,P., Johnsson,A., Wasteson,A., Westermark,B., Heldin,C.H., Huang,J.S., and Deuel,T.F.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 36, pp 9-9

Watson-L, "Public Accountability or Fiscal Control - Benchmarks of Performance in Australian Schooling", AUSTRALIAN JOURNAL OF EDUCATION 1996, Vol 40, Iss 1, pp 104-123

Watson-R, "Measuring Feeding Difficulty in Patients with Dementia - Perspectives and Problems", JOURNAL OF ADVANCED NURSING,1993, Vol 18, Iss 1, pp 25-31

Watsonboone-R, "The Information Needs and Habits of Humanities Scholars", RQ,1994, Vol 34, Iss 2, pp 203-216

Watt-IS Franks-AJ Sheldon-TA, "Health and Health-Care of Rural Populations in the UK - Is It Better or Worse", JOURNAL OF EPIDEMIOLOGY AND COMMUNITY HEALTH,1994, Vol 48, Iss 1, pp 16-21

Wattsrunge-AD Tollman-SG, "Child Neuropsychology - A Model for the Interpretation of Research and Assessment Findings", JOURNAL OF CLINICAL AND EXPERIMENTAL NEUROPSYCHOLOGY,1991, Vol 13, Iss 3, pp 438-438

Weary-G, "Self-Serving Causal Attributions Revisited - A Citation-Classic Commentary on Self-Serving Biases in the Attribution Process - A Reexamination of the Fact or Fiction Question - Weary,bG", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 46, pp 8-8

Webber-S, "Library-Performance-Indicators and Library-Management-
Tools, by S. Ward, J. Sumsion, D. Fuegi, I. Bloor", PROGRAM-AUTOMATED LIBRARY AND INFORMATION SYSTEMS 1996, Vol 30, Iss 4, pp 411-412

Weber-MC, "Towards Access, Accountability, Procedural Regularity and Participation - The Rehabilitation Act Amendments of ,1992 and ,1993", JOURNAL OF REHABILITATION,1994, Vol 60, Iss 3, pp 21-25

Webster-RE Hall-CW Bolen-LM, "Publication Productivity in Selected School-Psychology Journals - 1985-,1991", PSYCHOLOGY IN THE SCHOOLS,1993, Vol 30, Iss 2, pp 136-142

Wegmann-R, "About Peer Reviewing", CELLULAR AND MOLECULAR BIOLOGY,1993, Vol 39, Iss 8, pp R3-R4

Wegmann-R, "Continuing the Peer Reviewing - What Does It Mean - Foreword", CELLULAR AND MOLECULAR BIOLOGY,1994, Vol 40, Iss 6, pp R3-R4

Weick-A, "Should Publication Productivity Be the Primary Criterion for Tenure Decisions - Response to Marsh", JOURNAL OF SOCIAL WORK EDUCATION,1992, Vol 28, Iss 2, pp 139-140

Weimer-KH, "A Citation Comparison of Sourcebooks for Audiovisuals to AvlineRecords - Access and the Chief Source of Information", LIBRARY RESOURCES & TECHNICAL SERVICES,1994, Vol 38, Iss 2, pp 119-131

Weinberg-AM, "Origins of Criteria for Scientific Choice - A Citation-Classic Commentary on Criteria for Scientific Choice by Weinberg,A.M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 32, pp 10-10

Weinberg-AM, "Origins of Science and Trans-Science - A Citation-Classic Commentary on Science and Trans-Science by Weinberg,A.M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 34, pp 10-10

Weinberg-RA, "A Discovery of snRNA - A Citation-Classic Commentary on Small Molecular-Weight Monodisperse Nuclear-RNA by Weinberg,R.A., and Penman,S.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 34, pp 9-9

Weiner-D Weiner-J, "Research Mentor - A Tool to Aid in the Training of Scientific Investigators", BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY 1996, Vol 27, Iss 1, pp 5-14

Weintraub-TS Shimoguchi-W, "CatalogRecord Contents Enhancement", LIBRARY RESOURCES & TECHNICAL SERVICES,1993, Vol 37, Iss 2, pp 167-180

Weisburg-WG Brenner-DJ, "Nucleic-Acid Sequence Citations - Need for More-Specific Guidelines", JOURNAL OF CLINICAL MICROBIOLOGY,1993, Vol 31, Iss 2, pp 471-471

Weissman-A, "Amphetamine - Juxtaposition of Behavioral and Biochemical-Studies - A Citation-Classic Commentary on Antiamphetamine Effects Following Inhibition of Tyrosine-Hydroxylase by Weissman,A., Koe,B.K. and Tenen,S.S.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 12, pp 9-9

Weissman-A, "Amphetamine - Juxtaposition of Behavioral and Biochemical-Studies - A Citation-Classic Commentary on Antiamphetamine Effects Following Inhibition of Tyrosine-Hydroxylase by Weissman,A., Kow,B.K., and Tenen,S.S.", CURRENT CONTENTS/CLINICAL MEDICINE,1992, Iss 12, pp 10-10

Weitzman-ML, "What to Preserve - An Application of Diversity Theory to Crane Conservation", QUARTERLY JOURNAL OF ECONOMICS,1993, Vol 108, Iss 1, pp 157-183

Welch-JK, "Qualitative Evaluation and Research Methods, by M.Q. Patton", MODERN LANGUAGE JOURNAL,1992, Vol 76, Iss 4, pp 543-544

Welch-LS, "Information Behavior and Internationalization", INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT 1996, Vol 11, Iss 1-2, pp 179-191

Weller-AC, "Editorial Peer-Review - A Comparison of Authors

Publishing in 2 Groups of Us-Medical-Journals", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION 1996, Vol 84, Iss 3, pp 359-366

Weller-AC, "Potential Bias in Editorial Peer-Review - A Study of United-States Medical Journals", SERIALS LIBRARIAN,1991, Vol 19, Iss 3-4, pp 95-103

Werry-JS, "Teacher Ratings of Childrens Behavior Help Children and Science - A Citation-Classic Commentary on Conners Teacher Rating-Scale for Use in Drug Studies with Children - An Empirical-Study by Werry,J.S., Sprague,R.L., and Cohen,M.N.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 36, pp 8-8

Wesley-S Waring-EM, "A Critical-Review of Marital-Therapy Outcome Research", CANADIAN JOURNAL OF PSYCHIATRY-REVUE CANADIENNE DE PSYCHIATRIE 1996, Vol 41, Iss 7, pp 421-428

Wessely-S, "What Do We Know About Peer-Review", PSYCHOLOGICAL MEDICINE 1996, Vol 26, Iss 5, pp 883-886

West-CK Rhee-YH, "Ranking Departments or Sites Within Colleges of Education Using Multiple Standards - Departmental and Individual Productivity", CONTEMPORARY EDUCATIONAL PSYCHOLOGY,1995, Vol 20, Iss 2, pp 151-171

Westerling-R, "Studies of Avoidable Factors Influencing Death - A Call for Explicit Criteria", QUALITY IN HEALTH CARE 1996, Vol 5, Iss 3, pp 159-165

Westlander-G, "The Psychological Background of Pregnancy Outcome - A Critical-Evaluation of Research", WOMEN & HEALTH,1991, Vol 17, Iss 3, pp 79-99

Wetzel-RG, "Limnology - An Overview - A Citation-Classic Commentary on Limnology by Wetzel,R.G.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 36, pp 8-8

Whalley-B Munroe-G Landy-S Trew-S Macneil-J, "Publishing a Scholarly Journal on the World-Wide-Web", ASLIB PROCEEDINGS 1996, Vol 48, Iss 7-8, pp 171-176

Wheeler-JA, "New Light on the Correspondence Principle - A Citation-Classic Commentary on Semiclassical Description of Scattering by Ford,K.W. and Wheeler,J.A.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 40, pp 8-8

Whiffen-DH, "Characteristic Frequencies - A Citation-Classic Commentary on Vibrational Frequencies and Thermodynamic Properties of Fluoro-Benzene, Chloro-Benzene, Bromo-Benzene, and Iodo-Benzene by Whiffen,D.H.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 4, pp 8-8

White-A Hernandez-NR, "Trends in Article Citations in 3 Counseling Journals, 1952-1988", JOURNAL OF COUNSELING AND DEVELOPMENT,1991, Vol 69, Iss 5, pp 419-422

White-HD, "Literature Retrieval for Interdisciplinary Syntheses", LIBRARY TRENDS 1996, Vol 45, Iss 2, pp 239-264

White-RF Jacques-R, "Operationalizing the Postmodernity Construct for Efficient Organizational-Change Management", JOURNAL OF ORGANIZATIONAL CHANGE MANAGEMENT 1995, Vol 8, Iss 2, pp 45+

Whiteford-H, "Future-Directions for Mental-Health-Services in Australia", AUSTRALIAN JOURNAL OF PUBLIC HEALTH,1992, Vol 16, Iss 4, pp 350-353

Whitehand-JWR, "Fact and Fiction in Citation Rankings",

AREA,1992, Vol 24, Iss 3, pp 317-318

Whitney-G, "Access to Third-World Science in International Scientific and Technical Bibliographic Databases", SCIENTOMETRICS,1992, Vol 23, Iss 1, pp 201-219

Whitney-G, "Patterns of Authorship in Major Bibliographic Databases -The European Region", SCIENTOMETRICS,1993, Vol 26, Iss 2, pp 275-292

Wick-G, "The Peer-Review System - Still No Alternative in Sight", INTERNATIONAL ARCHIVES OF ALLERGY AND IMMUNOLOGY 1996, Vol 109, Iss 1, pp 1-2

Wickizer-TM Lessler-D Travis-KM, "Controlling Inpatient Psychiatric Utilization Through Managed Care", AMERICAN JOURNAL OF PSYCHIATRY 1996, Vol 153, Iss 3, pp 339-345

Wicks-S, "Peer-Review and Quality-Control in Higher-Education", BRITISH JOURNAL OF EDUCATIONAL STUDIES,1992, Vol 40, Iss 1, pp 57-68

Wiens-JA, "Ecological Crunches and Competition - A Citation-Classic Commentary on Competition and Variable Environments by Wiens,J.A.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1991, Iss 14, pp 10-10

Wight-C, "Incommensurability and Cross-Paradigm Communication in International-Relations Theory - Whats the Frequency Kenneth", MILLENNIUM-JOURNAL OF INTERNATIONAL STUDIES 1996, Vol 25, Iss 2, pp 291+

Wilczek-F, "The Birth of Axions - A Citation-Classic Commentary on Problem of Strong P and T Invariance in the Presence of Instantons by Wilczek,F.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1991, Iss 16, pp 8-9

Wilczynski-NL Walker-CJ Mckibbon-KA Haynes-RB, "Quantitative Comparison of Pre-Explosions and Subheadings with Methodologic Search Terms in Medline", JOURNAL OF THE AMERICAN MEDICAL INFORMATICS ASSOCIATION,1994, Iss S, pp 905-909

Wiley-RH, "Evolutionary Adaptations for Communication - A Citation-Classic Commentary on Physical Constraints on Acoustic Communication in the Atmosphere - Implications for the Evolution of Animal Vocalizations by Wiley,R.H. and Richards,D.G.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 48, pp 8-8

Wilkie-T, "Sources in Science - Who Can We Trust", LANCET 1996, Vol 347, Iss 9011, pp 1308-1311

Wilkins-P, "Performing Auditors - Assessing and Reporting the Performance of National Audit Offices - A 3-Country Comparison", AUSTRALIAN JOURNAL OF PUBLIC ADMINISTRATION 1995, Vol 54, Iss 4, pp 421-430

Wilkinson-GR, "Physiological Model of Drug Clearance - A Citation-Classic Commentary on a Physiological Approach to Hepatic Drug Clearance by Wilkinson,G.R., Shand,D.G.", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 46, pp 8-8

Wilkinson-J, "Using a Reconviction Predictor to Make Sense of Reconviction Rates in the Probation Service", BRITISH JOURNAL OF SOCIAL WORK,1994, Vol 24, Iss 4, pp 461-475

Willems-J Woudstra-E, "The Use by Biologists and Engineers of Nonspecialist Information-Sources and Its Relation to Their Social

Involvement", SCIENTOMETRICS,1993, Vol 28, Iss 2, pp 205-216

Williams-AF Reinfurt-D Wells-JK, "Increasing Seat-Belt Use in North-Carolina", JOURNAL OF SAFETY RESEARCH 1996, Vol.27, Iss 1, pp 33-41

Williams-B, "Performance Indicators in Higher-Education, by J. Johnes, J. Taylor", HIGHER EDUCATION,1992, Vol 23, Iss 2, pp 209-210

Williams-FP Mcshane-MD Sechrest-D, "Barriers to Effective Performance Review - The Seduction of Raw Data", PUBLIC ADMINISTRATION REVIEW,1994, Vol 54, Iss 6, pp 537-542

Williams-GM, "Long-Term Rat-Liver Epithelial-Cell Cultures - A Citation-Classic Commentary on Isolation and Long-Term Cell-Culture of Epithelial-Like Cells from Rat-Liver by Williams,G.M., Weisburger,E.K. and Weisburger,J.H. and Long-Term Cell-Culture of Adult-Rat Liver Epithelial-Cells by Williams,G.M., and Gunn,J.M.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 46, pp 11-11

Williams-JE, "Gender-Related Worry and Emotionality Test Anxiety for High-Achieving Students", PSYCHOLOGY IN THE SCHOOLS 1996, Vol 33, Iss 2, pp 159-162

Williams-RB, "Pursuing the Noble Hypothesis - A Citation-Classic Commentary on Type-A Behavior, Hostility, and Coronary Atherosclerosis by Williams,Rb, Haney,Tl, Lee,Kl, Kong,Yh, Blumenthal,Ja, Whalen,Re", CURRENT CONTENTS/CLINICAL MEDICINE,1993, Iss 22, pp 8-8

Williams-RC Carta-JJ, "Behavioral Outcomes of Young-Children with Prenatal Exposure to Alcohol - Review and Analysis of Experimental Literature", INFANTS AND YOUNG CHILDREN 1996, Vol 8, Iss 4, pp 16-28

Williamson-JD Fried-LP, "Characterization of Older Adults Who Attribute Functional Decrements to Old-Age", JOURNAL OF THE AMERICAN GERIATRICS SOCIETY 1996, Vol 44, Iss 12, pp 1429-1434

Willis-A, "Fundholding - A Possible Inverse Performance Indicator for Health Authorities", BRITISH MEDICAL JOURNAL,1991, Vol 302, Iss 6788, pp 1340-1340

Wilmore-DW, "Growth in Infants Receiving Intravenous Nutrition - A Citation-Classic Commentary on Total Parenteral-Nutrition in Infants with Catastrophic Gastrointestinal Anomalies by Wilmore,D.W., Groff,D.B., Bishop,H.C. and Dudrick,S.J.", CURRENT CONTENTS/CLINICAL MEDICINE,1991, Iss 30, pp 10-10

Wilson-EO, "Sociality at the Pinnacle - A Citation-Classic Commentary on the Insect Societies by Wilson,E.O.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 16, pp 8-8

Wilson-EO, "Sociality at the Pinnacle - A Citation-Classic Commentary on the Insect Societies by Wilson,E.O.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1993, Iss 10, pp 8-8

Wilson-MG Holman-PB Hammock-A, "A Comprehensive Review of the Effects of Worksite Health Promotion on Health-Related Outcomes", AMERICAN JOURNAL OF HEALTH PROMOTION 1996, Vol 10, Iss 6, pp 429-435

Wilson-TD, "A Local Study of Journal Use", JOURNAL OF INFORMATION SCIENCE,1994, Vol 20, Iss 6, pp 444-450

Wilson-TD, "Monitoring and Evaluating Information-Related Research", EDUCATION FOR INFORMATION 1996, Vol 14, Iss 2, pp 85-93

Wilson-TD Depaulo-BM Mook-DG Klaaren-KJ, "Scientists Evaluations of Research - The Biasing Effects of the Importance of the Topic", PSYCHOLOGICAL SCIENCE,1993, Vol 4, Iss 5, pp 322-325

Wilsonbarnett-J, "Measuring the Effectiveness of Nurse Education - The Use of Performance Indicators, by A. Narayanasamy", JOURNAL OF ADVANCED NURSING,1994, Vol 19, Iss 1, pp 204-204

Winclawska-BM, "Polish Sociology Citation Index (Principles for Creation and the First Results)", SCIENTOMETRICS 1996, Vol 35, Iss 3, pp 387-391

Wing-KT, "Lessons from Experience - The Role of Research in Improving Substance-Abuse Prevention", JOURNAL OF COMMUNITY PSYCHOLOGY,1993, Vol 21, Iss 3, pp 246-255

Wingate-CL, "NIH Peer-Review of Grant Applications - Definitions, Procedures, and Suggestions", INVESTIGATIVE RADIOLOGY,1993, Vol 28, Iss S2, pp S38-S40

Winters-NC, "Family Preservation Services - Research and Evaluation, by K. Wells, D. Biegel", JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY,1992, Vol 31, Iss 4, pp 759-760

Wissmann-C, "Techniques of Data-Retrieval for Scientometric Research in the ISI Citation Indexes", JOURNAL OF INFORMATION SCIENCE,1993, Vol 19, Iss 5, pp 363-376

Witten-TA, "Fractal Growth - A Continuing Mystery - A Citation-Classic Commentary on Diffusion-Limited Aggregation, a Kinetic Critical Phenomenon by Witten,T.A., and Sander,L.M.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1993, Iss 18, pp 8-8

Wodarski-JS, "Promoting Research Productivity Among University-Faculty - An Evaluation", RESEARCH ON SOCIAL WORK PRACTICE,1991, Vol 1, Iss 3, pp 278-288

Woehr-DJ Huffcutt-AI, "Rater Training for Performance-Appraisal - A Quantitative Review", JOURNAL OF OCCUPATIONAL AND ORGANIZATIONAL PSYCHOLOGY,1994, Vol 67, Iss SEP, pp 189-205

Wohlgenant-MK, "Distribution of Gains from Research and Promotion in Multistage Production Systems - The Case of the United-States Beef and Pork Industries", AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS,1993, Vol 75, Iss 3, pp 642-651

Woinarski-J, "Keast,James,Allen - DL-Serventy-Medal 1995 - Citation", EMU 1995, Vol 95, Iss DEC, pp 301-301

Wolch-JR West-K Gaines-TE, "Transspecies Urban Theory", ENVIRONMENT AND PLANNING D-SOCIETY & SPACE 1995, Vol 13, Iss 6, pp 735-760

Wolek-FW Sanchez-PM, "Research Administrators as Invisible College Facilitators", SRA-JOURNAL OF THE SOCIETY OF RESEARCH ADMINISTRATORS,1993, Vol 24, Iss 4, pp 27-34

Wolf-M, "Why Did Social Validity Become a Classic - A Citation-Classic Commentary on Social Validity - The Case for Subjective Measurement or How Applied Behavior Analysis Is Finding Its Heart by Wolf,M.M.", CURRENT CONTENTS/SOCIAL & BEHAVIORAL SCIENCES,1991, Iss 2, pp 8-8

Wolf-WJ, "Physical and Chemical-Properties of Soybean Proteins - A Citation-Classic Commentary on Soybean Proteins - Their Functional, Chemical, and Physical-Properties by Wolf,W.J.", CURRENT

CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1992, Iss 38, pp 8-8

Wolff-S, "The Production of Harlequin Chromosomes - A Citation-Classic Commentary on New Giemsa Method for the Differential Staining of Sister Chromatids by Perry,P., and Wolff,S.", CURRENT CONTENTS/LIFE SCIENCES,1993, Iss 36, pp 9-9

Wolff-SP, "Reform Options for Peer-Review", NATURE,1993, Vol 364, Iss 6434, pp 183-183

Wood-AS Tupholme-GE Bhatti-MIH Heggs-PJ, "Performance Indicators for Steady-State Heat-Transfer Through Fin Assemblies", JOURNAL OF HEAT TRANSFER-TRANSACTIONS OF THE ASME 1996, Vol 118, Iss 2, pp 310-316

Wood-RDH, "Psychoanalysis in Britain - Points of Cultural Access, 1893-1918", INTERNATIONAL JOURNAL OF PSYCHO-ANALYSIS,1995, Vol 76, Iss FEB, pp 135-151

Woodroffe-C, "Performance Indicator Packs Flawed", BRITISH MEDICAL JOURNAL,1991, Vol 302, Iss 6787, pp 1232-1233

Woolf-SH Diguiseppi-CG Atkins-D Kamerow-DB, "Developing Evidence-Based Clinical-Practice Guidelines - Lessons Learned by the Us Preventive Services Task-Force", ANNUAL REVIEW OF PUBLIC HEALTH 1996, Vol 17, pp 511-538

Wormald-RPL, "Preschool Vision Screening in Cornwall - Performance Indicators of Community Orthoptists", ARCHIVES OF DISEASE IN CHILDHOOD,1991, Vol 66, Iss 8, pp 917-920

Wouters-P Leydesdorff-L, "Has Price Dream Come True - Is Scientometrics a Hard Science", SCIENTOMETRICS,1994, Vol 31, Iss 2, pp 193-222

Wright-HH Holmes-GR Cuccaro-ML Leonhardt-TV, "A Guided Bibliography of the Selective Mutism (Elective Mutism) Literature", PSYCHOLOGICAL REPORTS,1994, Vol 74, Iss 3, pp 995-1007

Wright-RA Carroll-K, "From Vanguard to Vanished - The Declining Influence of Criminology Textbooks on Scholarship", JOURNAL OF CRIMINAL JUSTICE,1994, Vol 22, Iss 6, pp 559-567

Wright-RA Cohn-EG, "The Most-Cited Scholars in Criminal-Justice Textbooks, 1989-1993", JOURNAL OF CRIMINAL JUSTICE 1996, Vol 24, Iss 5, pp 459-467

Wurth-P, "Professional Accountability and Peer-Review", AUSTRALIAN AND NEW ZEALAND JOURNAL OF PSYCHIATRY,1992, Vol 26, Iss 4, pp 688-688

Xavier-P, "Performance Indicators for Public Telecommunications Operators - Will They Improve Performance", TELECOMMUNICATIONS POLICY,1991, Vol 15, Iss 2, pp 137-150

Xavier-P, "Performance Indicators for Public Telecommunications Operators - Will They Improve Performance", TELECOMMUNICATIONS POLICY,1991, Vol 15, Iss 2, pp 137-150

Xu-XY, "Policy Evaluation in China Housing Reform", EVALUATION AND PROGRAM PLANNING,1993, Vol 16, Iss 1, pp 39-47

Yagi-E Badash-L Beaver-DD, "Price,Derek,J.de,S. (1922-83) - Historian of Science and Herald of Scientometrics", INTERDISCIPLINARY SCIENCE REVIEWS 1996, Vol 21, Iss 1, pp 64-84

Yamazaki-S, "Research Activities in Life Sciences in Japan", SCIENTOMETRICS,1994, Vol 29, Iss 2, pp 181-190

Yancey-PH, "Micromolecules That Help Macromolecules in Dehydration - A Citation-Classic Commentary on Living with Water-Stress - Evolution of Osmolyte Systems by Yancey,P.H., Clarke,M.E., Hand,S.C., Bowlus,R.D. and Somero,G.N.", CURRENT CONTENTS/AGRICULTURE BIOLOGY & ENVIRONMENTAL SCIENCES,1993, Iss 44, pp 8-8

Yashin-YI, "Scientometric Study of the State and Developmental Tendencies of Chromatographic Methods and Apparatus", JOURNAL OF ANALYTICAL CHEMISTRY,1993, Vol 48, Iss 3, pp 290-298

Yerkey-AN, "Publishing in Library and Information-Science - Audience, Subjects, Affiliation, Source, and Format", LIBRARY & INFORMATION SCIENCE RESEARCH,1993, Vol 15, Iss 2, pp 165-184

Yerkey-N, "Topos - An Advice System for the Invention of Persuasive Arguments", JOURNAL OF EDUCATIONAL COMPUTING RESEARCH,1993, Vol 9, Iss 4, pp 519-534

Yitzhaki-M, "Relation of Title Length of Journal Articles to Number of Authors", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 321-332

Yitzhaki-M Bentamar-D, "Number of References in Biochemistry and Other Fields - A Case-Study of the Journal of Biological Chemistry Throughout 1910 - 1985", SCIENTOMETRICS,1991, Vol 21, Iss 1, pp 3-22

Yoon-LL, "The Performance of Cited References as an Approach to Information-Retrieval", JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE,1994, Vol 45, Iss 5, pp 287-299

Yorke-M, "Performance Indicators - Towards a Synoptic Framework", HIGHER EDUCATION,1991, Vol 21, Iss 2, pp 235-248

Yosipovitch-G Heller-I Belhassen-B, "Bibliometric Study of Cardiology in Israel in 1978, 1983 and 1988", ISRAEL JOURNAL OF MEDICAL SCIENCES,1991, Vol 27, Iss 4, pp 234-238

Young-VR Munro-HN, "Index of Muscle Protein-Degradation - A Citation-Classic Commentary on N-Tau-Methylhistidine (3-Methyl Histidine) and Muscle Protein-Turnover - An Overview by Young,V.R. and Munro,H.N.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 38, pp 9-9

Yunker-JA, "Evaluating Changes in the Distribution of Capital Wealth", ECONOMIC INQUIRY,1994, Vol 32, Iss 4, pp 597-615

Yus-ES, "Please, Mind the Citations of Spanish Journals in Medicina-Clinica", MEDICINA CLINICA 1996, Vol 107, Iss 8, pp 319-319

Yuthavong-Y Phornsadja-K Chungcharoen-A Eisemon-TO Davis-CH, "Communication Strategies in Tissue-Culture and Seed Research in Thailand", SCIENTOMETRICS,1993, Vol 28, Iss 1, pp 41-60

Zachos-G, "Research Output Evaluation of 2 University Departments in Greece with the Use of Bibliometric Indicators", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 195-221

Zajac-S, "Industrial-Research Impact on the Changes in the Slovak Industry", EKONOMICKY CASOPIS,1992, Vol 40, Iss 2, pp 148-162

Zamarripa-EJ, "Research Productivity - A Definition", MENTAL RETARDATION,1993, Vol 31, Iss 5, pp 320-325

Zeckhauser-R, "The Challenge of Contracting for Technological Information", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 1996, Vol 93, Iss 23, pp 12743-12748

Zentall-TR, "What to Do About Peer-Review - Is the Cure Worse Than the Disease", BEHAVIORAL AND BRAIN SCIENCES,1991, Vol 14, Iss 1,

pp 166-166
Zeuli-JS, "How Do Teachers Understand Research When They Read It", TEACHING AND TEACHER EDUCATION,1994, Vol 10, Iss.1, pp 39-55
Zhang-HQ, "A Bibliometric Study on Medicine Chinese Traditional in Medline Database", SCIENTOMETRICS,1994, Vol 31, Iss 3, pp 241-250
Zhang-HQ, "Research Performance in Key Medical Universities in China Observed from the Scientific Productivity", SCIENTOMETRICS 1996, Vol 37, Iss 1, pp 177-190
Zhu-J Meadows-AJ Mason-G, "Citations and Departmental Research Ratings", SCIENTOMETRICS,1991, Vol 21, Iss 2, pp 171-179
Zienkiewicz-OC, "Defining Finite - A Citation-Classic Commentary on the Finite-Element Method in Structural and Continuum-Mechanics by Zienkiewicz,O.C., and Taylor,R.L.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 2, pp 8-8
Zinder-M, "How Can Cognitive Research Be of Benefit of Rehabilitation in Organic Geriatric Psychiatry", SCHWEIZERISCHE ZEITSCHRIFT FUR PSYCHOLOGIE-REVUE SUISSE DE PSYCHOLOGIE,1993, Vol 52, Iss 3, pp 157-166
Zink-S Illes-J Vannier-MW, "NLM Extramural Program - Frequently Asked Questions", BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION 1996, Vol 84, Iss 2, pp 165-181
Zitt-M, "A Simple Method for Dynamic Scientometrics Using Lexical Analysis", SCIENTOMETRICS,1991, Vol 22, Iss 1, pp 229-252
Zitt-M Bassecoulard-E, "Development of a Method for Detection and Trend Analysis of Research Fronts Built by Lexical or Cocitation Analysis", SCIENTOMETRICS,1994, Vol 30, Iss 1, pp 333-351
Zitt-M Bassecoulard-E, "Reassessment of Cocitation Methods for Science Indicators - Effect of Methods Improving Recall Rates", SCIENTOMETRICS 1996, Vol 37, Iss 2, pp 223-244
Zitt-M Teixeira-N, "Science Macro-Indicators - Some Aspects of Ost Experience", SCIENTOMETRICS 1996, Vol 35, Iss 2, pp 209-222
Zoebisch-EG, "AM1 - A Quantum-Mechanical Molecular-Model - A Citation-Classic Commentary on the Development and Use of Quantum-Mechanical Molecular-Models .76. AM1 - A New General-Purpose Quantum-Mechanical Molecular-Model by Dewar,M.J.S., Zoebisch,E.G., Healy,E.F., Stewart,J.J.P.", CURRENT CONTENTS/PHYSICAL CHEMICAL & EARTH SCIENCES,1993, Iss 46, pp 8-8
Zollinger-RM, "The Intent of Peer-Reviewed Journals - Reply", AMERICAN JOURNAL OF SURGERY,1992, Vol 163, Iss 6, pp 635-635
Zornig-P Altmann-G, "Unified Representation of Zipf Distributions", COMPUTATIONAL STATISTICS & DATA ANALYSIS,1995, Vol 19, Iss 4, pp 461-473
Zucker-LG Darby-MR, "Star Scientists and Institutional Transformation - Patterns of Invention and Innovation in the Formation of the Biotechnology Industry", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 1996, Vol 93, Iss 23, pp 12709-12716
Zukin-SR Zukin-RS, "PCP and Multiple Opiate Receptors - A Citation-Classic Commentary on (H-3) Phencyclidine Binding in Rat Central-Nervous-System by Zukin,S.R., and Zukin,R.S. and Demonstration of (H-3) Cyclazocine Binding to Multiple Opiate Receptor-Sites by Zukin,R.S., and Zukin,S.R. and Multiple Opiate

Receptors - Emerging Concepts by Zukin,R.S., and Zukin,S.R.", CURRENT CONTENTS/LIFE SCIENCES,1992, Iss 8, pp 9-9

Zurer-PS, "NIH Peer Reviewers to Watch for High-Risk, High-Payoff Proposals", CHEMICAL & ENGINEERING NEWS,1993, Vol 71, Iss 23, pp 25-26

Zwanzig-R, "A Shortcut to Irreversibility - A Citation-Classic Commentary on Ensemble Method in the Theory of Irreversibility by Zwanzig,R.", CURRENT CONTENTS/ENGINEERING TECHNOLOGY & APPLIED SCIENCES,1992, Iss 2, pp 8-8

XI. MOST CITED PAPERS

GARFIELD-E-1979-CITATION-INDEXING 55
SCHUBERT-A-1989-SCIENTOMETRICS-V16-P3 40
GARFIELD-E-1972-SCIENCE-V178-P471 40
SMALL-H-1973-J-AM-SOC-INFORM-SCI-V24-P265 35
LOTKA-AJ-1926-J-WASHINGTON-ACADEMY-V16-P317 35
KUHN-TS-1970-STRUCTURE-SCI-REVOLU 33
PRICE-DD-1963-LITTLE-SCI-BIG-SCI 32
COLE-JR-1973-SOCIAL-STRATIFICATIO 29
NARIN-F-1976-EVALUATIVE-BIBLIOMET 27
SMITH-LC-1981-LIBR-TRENDS-V30-P83 25
CRANE-D-1972-INVISIBLE-COLLEGES 24
PETERS-DP-1982-BEHAVIORAL-BRAIN-SCI-V5-P187 22
MERTON-RK-1973-SOCIOLOGY-SCI 22
MARTIN-BR-1983-RES-POLICY-V12-P61 22
SMALL-HG-1974-SCI-STUD-V4-P17 21
HAMILTON-DP-1990-SCIENCE-V250-P1331 20
MORAVCSIK-MJ-1975-SOC-STUD-SCI-V5-P86 19
KING-J-1987-J-INFORM-SCI-V13-P261 19
HOWARD-GS-1987-AM-PSYCHOL-V42-P975 19
CRONIN-B-1984-CITATION-PROCESS 19
CHUBIN-DE-1990-PEERLESS-SCI-PEER-RE 19
PRICE-DD-1965-SCIENCE-V149-P510 18
MACROBERTS-MH-1989-J-AM-SOC-INFORM-SCI-V40-P342 18
CALLON-M-1986-MAPPING-DYNAMICS-SCI 18
BRADFORD-SC-1934-ENGINEERING-LONDON-V137-P85 18
SMALL-H-1985-SCIENTOMETRICS-V8-P321 17
PRICE-DD-1976-J-AM-SOC-INFORM-SCI-V27-P292 17
LINDSEY-D-1980-SOC-STUD-SCI-V10-P145 17
ZUCKERMAN-H-1971-MINERVA-V9-P66 16
SMALL-H-1985-J-INFORM-SCI-V11-P147 16
SCHUBERT-A-1990-SCIENTOMETRICS-V19-P3 16
BRAUN-T-1985-SCIENTOMETRIC-INDICA 16
ALLISON-PD-1974-AM-SOCIOL-REV-V39-P596 16
FOX-MF-1983-SOC-STUD-SCI-V13-P285 15
EGGHE-L-1990-INTRO-INFORMETRICS 15
VINKLER-P-1988-SCIENTOMETRICS-V13-P239 14
SMALL-HG-1978-SOC-STUD-SCI-V8-P327 14

MOED-HF-1985-RES-POLICY-V14-P131 14
LIEBOWITZ-SJ-1984-J-ECON-LIT-V22-P77 14
HAMILTON-DP-1991-SCIENCE-V251-P25 14
FRAME-JD-1979-SOC-STUD-SCI-V9-P481 14
BEAVER-DD-1978-SCIENTOMETRICS-V1-P65 14
MACROBERTS-MH-1986-SOC-STUD-SCI-V16-P151 13
KESSLER-MM-1963-AM-DOC-V14-P10 13
EDGE-D-1979-HIST-SCI-V17-P102 13
COX-WM-1977-AM-PSYCHOL-V32-P793 13
BRAUN-T-1988-SCIENTOMETRICS-V14-P3 13
SCHUBERT-A-1986-SCIENTOMETRICS-V9-P281 12
ROOSE-KD-1970-RATING-GRADUATE-PROG 12
PAO-ML-1989-J-AM-SOC-INFORM-SCI-V40-P226 12
NEDERHOF-AJ-1989-SCIENTOMETRICS-V15-P423 12
NARIN-F-1987-RES-POLICY-V16-P143 12
MERTON-RK-1968-SCIENCE-V159-P56 12
LATOUR-B-1979-LABORATORY-LIFE-SOCI 12
HORROBIN-DF-1990-JAMA-J-AM-MED-ASSOC-V263-P1438 12
GARFIELD-E-1955-SCIENCE-V122-P108 12
COLE-S-1981-SCIENCE-V214-P881 12
CICCHETTI-DV-1991-BEHAV-BRAIN-SCI-V14-P119 12
BROOKES-BC-1969-NATURE-V224-P953 12
WHITE-HD-1989-ANNU-REV-INFORM-SCI-V24-P119 11
VANRAAN-AFJ-1988-HDB-QUANTITATIVE-STU 11
TODOROV-R-1988-J-INFORM-SCI-V14-P47 11
PRICE-DJD-1963-LITTLE-SCI-BIG-SCI 11
PRICE-DD-1966-AM-PSYCHOL-V21-P1011 11
MORAVCSIK-MJ-1984-SCIENTOMETRICS-V6-P75 11
MOED-HF-1985-SCIENTOMETRICS-V8-P177 11
MCNUTT-RA-1990-JAMA-J-AM-MED-ASSOC-V263-P1371 11
MAHONEY-MJ-1977-COGNITIVE-THERAPY-RE-V1-P161 11
LONG-JS-1981-AM-SOCIOL-REV-V46-P422 11
HEALEY-P-1986-RES-POLICY-V15-P233 11
COURTIAL-JP-1989-SCIENTOMETRICS-V15-P527 11
CALLON-M-1983-SOC-SCI-INFORM-V22-P191 11
BURTON-RE-1960-AM-DOC-V11-P18 11
BRAUN-T-1988-SCIENTOMETRICS-V13-P181 11
BRADFORD-SC-1948-DOCUMENTATION 11
BORGMAN-CL-1990-SCHOLARLY-COMMUNICAT 11
BAILAR-JC-1985-NEW-ENGL-J-MED-V312-P654 11
SMALL-H-1985-SCIENTOMETRICS-V7-P391 10
PRITCHARD-A-1969-J-DOC-V25-P348 10
LOWRY-OH-1951-J-BIOL-CHEM-V193-P265 10
LOCK-S-1985-DIFFICULT-BALANCE-ED 10
LINDSEY-D-1989-SCIENTOMETRICS-V15-P189 10
LEIMKUHLER-FF-1967-J-DOC-V23-P197 10
KUHN-TS-1962-STRUCTURE-SCI-REVOLU 10
JONES-LV-1982-ASSESSMENT-RES-DOCTO 10
HIRST-G-1978-J-AM-SOC-INFORM-SCI-V29-P171 10
GILBERT-GN-1977-SOC-STUD-SCI-V7-P113 10
CRANE-D-1965-AM-SOCIOL-REV-V30-P699 10
BROOKS-TA-1986-J-AM-SOC-INFORM-SCI-V37-P34 10

BRAUN-T-1988-SCIENTOMETRICS-V14-P365 10
BEAVER-DD-1979-SCIENTOMETRICS-V1-P133 10
ANDERSON-J-1988-SCI-PUBL-POLICY-V15-P153 10
ALLISON-PD-1980-SOC-STUD-SCI-V10-P163 10
ZIPF-GK-1949-HUMAN-BEHAVIOR-PRINC 9
SMALL-HG-1977-SOC-STUD-SCI-V7-P139 9
SICHEL-HS-1985-J-AM-SOC-INFORM-SCI-V36-P314 9
SCHUBERT-A-1984-SCIENTOMETRICS-V6-P149 9
RESKIN-BF-1977-AM-SOCIOL-REV-V42-P491 9
RENNIE-D-1990-JAMA-J-AM-MED-ASSOC-V263-P1317 9
PRICE-DJD-1965-SCIENCE-V149-P510 9
PETERS-HPF-1993-RES-POLICY-V22-P23 9
PATTON-MQ-1990-QUALITATIVE-EVALUATI 9
MCCAIN-KW-1986-J-AM-SOC-INFORM-SCI-V37-P111 9
KYVIK-S-1989-SCIENTOMETRICS-V15-P205 9
JOHNES-J-1990-PERFORMANCE-INDICATO 9
HARGENS-LL-1988-AM-SOCIOL-REV-V53-P139 9
HAGSTROM-WO-1965-SCIENTIFIC-COMMUNITY 9
GROSS-PLK-1927-SCIENCE-V66-P385 9
GARFIELD-E-1979-SCIENTOMETRICS-V1-P359 9
FRAME-JD-1977-INTERSCIENCIA-V2-P143 9
ENDLER-NS-1978-AM-PSYCHOL-V33-P1064 9
CULNAN-MJ-1986-MANAGE-SCI-V32-P156 9
COLE-S-1967-AM-SOCIOL-REV-V32-P377 9
BROAD-WJ-1981-SCIENCE-V211-P1137 9
BLACKBURN-RT-1978-SOCIOL-EDUC-V51-P132 9
ZUCKERMAN-H-1977-SCI-ELITE-NOBEL-LAUR 8
YANKAUER-A-1990-JAMA-J-AM-MED-ASSOC-V263-P1338 8
WATSON-JD-1953-NATURE-V171-P737 8
VARLEJS-J-1986-J-EDUC-LIBR-INF-SCI-V27-P71 8
SMALL-HG-1979-SCIENTOMETRICS-V1-P445 8
SALTON-G-1983-INTRO-MODERN-INFORMA 8
ROSE-RN-1980-AM-J-AGR-ECON-V62-P834 8
RIP-A-1984-SCIENTOMETRICS-V6-P381 8
RICE-RE-1989-SCIENTOMETRICS-V15-P257 8
RENNIE-D-1986-JAMA-J-AM-MED-ASSOC-V256-P2391 8
PENDLEBURY-DA-1991-SCIENCE-V251-P1410 8
PAO-ML-1986-J-AM-SOC-INFORM-SCI-V37-P26 8
NEDERHOF-AJ-1989-AM-PSYCHOL-V44-P734 8
NARIN-F-1989-SCIENCE-V245-P600 8
MYERS-CR-1970-AM-PSYCHOL-V25-P1041 8
MCCAIN-KW-1991-LIBR-QUART-V61-P311 8
MARTIN-BR-1990-SCI-PUBL-POLICY-V17-P14 8
LINDSEY-D-1978-SCI-PUBLICATION-SYST 8
LINDNER-RK-1978-AM-J-AGR-ECON-V60-P48 8
LAWANI-SM-1986-SCIENTOMETRICS-V9-P13 8
KRAUSKOPF-M-1986-SCIENTOMETRICS-V10-P199 8
KAPLAN-N-1965-AM-DOC-V16-P179 8
HOWARD-GS-1983-J-COUNS-PSYCHOL-V30-P600 8
GARFIELD-E-1986-ANN-INTERN-MED-V105-P313 8
EPSTEIN-WM-1990-SCI-TECHNOL-V15-P9 8
CULNAN-MJ-1987-MIS-QUART-V11-P341 8

COHEN-J-1977-STATISTICAL-POWER-AN 8
CARTTER-AM-1966-ASSESSMENT-QUALITY-G 8
CALLON-M-1991-SCIENTOMETRICS-V22-P155 8
BROOKES-BC-1968-J-DOC-V24-P247 8
BRAUN-T-1987-SCIENTOMETRICS-V11-P9 8
BAYER-AE-1966-SOCIOL-EDUC-V39-P381 8
ARUNACHALAM-S-1981-J-INFORM-SCI-V3-P13 8
ARUNACHALAM-S-1985-SCIENTOMETRICS-V8-P301 8
ZIMAN-JM-1968-PUBLIC-KNOWLEDGE-SOC 7
WILSON-JD-1978-J-CLIN-INVEST-V61-P1697 7
WHITLEY-R-1984-INTELLECTUAL-SOCIAL 7
VINKLER-P-1988-SCIENTOMETRICS-V14-P453 7
STINSON-ER-1987-J-INFORM-SCI-V13-P65 7
SCOTT-WA-1974-AM-PSYCHOL-V29-P698 7
RUSHTON-P-1984-B-BRIT-PSYCHOL-SOC-V37-P33 7
RUBENSTEIN-LV-1990-JAMA-J-AM-MED-ASSOC-V264-P1974 7
RELMAN-AS-1989-NEW-ENGL-J-MED-V321-P827 7
RAVNSKOV-U-1992-BMJ-V305-P15 7
PRICE-DD-1970-COMMUNICATION-SCI-EN-P3 7
PRICE-DD-1986-LITTLE-SCI-BIG-SCI 7
PETERS-HPF-1993-RES-POLICY-V22-P47 7
PERITZ-BC-1981-LIBR-RES-V3-P47 7
PERITZ-BC-1983-SCIENTOMETRICS-V5-P211 7
OXMAN-AD-1991-J-CLIN-EPIDEMIOL-V44-P91 7
NOUR-MM-1985-LIBR-INFORM-SCI-RES-V7-P261 7
MOED-HF-1989-SCIENTOMETRICS-V15-P473 7
MCCAIN-KW-1990-J-AM-SOC-INFORM-SCI-V41-P433 7
MCCAIN-KW-1989-J-AM-SOC-INFORM-SCI-V40-P110 7
LONG-JS-1978-AM-SOCIOL-REV-V43-P889 7
LINE-MB-1974-J-DOC-V30-P283 7
KOSTOFF-RN-1993-ASSESSING-R-D-IMPACT 7
KENDALL-MG-1960-OPERATIONAL-RESEARCH-V11-P31 7
JOHNES-G-1988-HIGHER-ED-Q-V42-P54 7
INGELFINGER-FJ-1974-AM-J-MED-V56-P686 7
HAYNES-RB-1990-ANN-INTERN-MED-V112-P78 7
GUBA-EG-1989-4TH-GENERATION-EVALU 7
GRILICHES-Z-1990-J-ECON-LIT-V28-P1661 7
GRIFFITH-BC-1974-SCI-STUD-V4-P339 7
GOTTFREDSON-SD-1978-AM-PSYCHOL-V33-P920 7
GOFFMAN-W-1969-NATURE-V221-P1205 7
GARFUNKEL-JM-1990-JAMA-J-AM-MED-ASSOC-V263-P1369 7
FRAME-JD-1977-SOC-STUD-SCI-V7-P501 7
EVANS-JT-1990-JAMA-J-AM-MED-ASSOC-V263-P1353 7
DIAMOND-AM-1986-J-HUM-RESOUR-V21-P200 7
DELACEY-G-1985-BRIT-MED-J-V291-P884 7
CRANE-D-1967-AM-SOCIOL-V2-P195 7
COZZENS-SE-1989-SCIENTOMETRICS-V15-P437 7
COLE-J-1971-AM-SOCIOL-V6-P23 7
COHEN-J-1960-EDUC-PSYCHOL-MEAS-V20-P37 7
CHUBIN-DE-1975-SOC-STUD-SCI-V5-P423 7
CAVE-M-1988-USE-PERFORMANCE-INDI 7
CARPENTER-MP-1988-SCIENTOMETRICS-V14-P213 7

CANO-V-1989-J-AM-SOC-INFORM-SCI-V40-P284 7
BROOKES-BC-1977-J-DOC-V33-P180 7
BRAUN-T-1987-SCIENTOMETRICS-V11-P127 7
BRAUN-T-1989-SCIENTOMETRICS-V15-P165 7
BRAUN-T-1987-SCIENTOMETRICS-V12-P3 7
BRAAM-RR-1991-J-AM-SOC-INFORM-SCI-V42-P233 7
ARUNACHALAM-S-1985-J-INFORM-SCI-V10-P165 7
ZUCKERMAN-H-1967-AM-SOCIOL-REV-V32-P391 6
WINDSOR-DA-1973-J-AM-SOC-INFORM-SCI-V24-P377 6
WHITTAKER-J-1989-SOC-STUD-SCI-V19-P473 6
WEINGART-P-1984-VERMESSUNG-FORSCHUNG 6
WATSON-PD-1985-COLL-RES-LIBR-V46-P334 6
WANNER-RA-1981-SOCIOL-EDUC-V54-P238 6
WADE-N-1975-SCIENCE-V188-P429 6
VLACHY-J-1985-SCIENTOMETRICS-V7-P505 6
VELHO-L-1986-SCIENTOMETRICS-V9-P71 6
VANRAAN-AFJ-1993-SCIENTOMETRICS-V26-P169 6
TIJSEEN-RJW-1987-SCIENTOMETRICS-V11-P351 6
THYER-BA-1986-J-SOC-WORK-EDUC-V22-P67 6
SWEETLAND-JH-1989-LIBR-QUART-V59-P291 6
SUBRAMANYAM-K-1983-J-INFORM-SCI-V6-P33 6
SPAGNOLO-F-1990-SCIENTOMETRICS-V18-P205 6
SMALL-H-1980-SCIENTOMETRICS-V2-P277 6
SIMON-HA-1955-BIOMETRIKA-V42-P425 6
SIEGEL-S-1956-NONPARAMETRIC-STATIS 6
SEGLEN-PO-1992-J-AM-SOC-INFORM-SCI-V43-P628 6
SCHUBERT-A-1983-SCIENTOMETRICS-V5-P59 6
SCHUBERT-A-1988-HDB-QUANTITATIVE-STU-P137 6
SCHMOOKLER-J-1966-INVENTION-EC-GROWTH 6
SARACEVIC-T-1988-J-AM-SOC-INFORM-SCI-V39-P197 6
ROCHE-M-1982-INTERCIENCIA-V7-P279 6
PRATT-AD-1977-J-AM-SOC-INFORM-SCI-V28-P285 6
PORTER-AL-1977-SOC-STUD-SCI-V7-P257 6
PINSKI-G-1976-INFORMATION-PROCESSI-V12-P297 6
PERSSON-O-1988-HDB-QUANTITATIVE-STU-P229 6
PERITZ-BC-1983-SCIENTOMETRICS-V5-P303 6
PERITZ-BC-1992-J-AM-SOC-INFORM-SCI-V43-P448 6
PERITZ-BC-1980-LIBR-RES-V2-P251 6
PAVITT-K-1985-SCIENTOMETRICS-V7-P77 6
PAO-ML-1985-INFORM-PROCESS-MANAG-V21-P305 6
NOMA-E-1982-SCIENTOMETRICS-V4-P297 6
NARIN-F-1985-SCIENTOMETRICS-V7-P369 6
NARIN-F-1991-SCIENTOMETRICS-V21-P313 6
NARIN-F-1989-EVALUATION-SCI-RES 6
MOED-HF-1989-J-INFORM-SCI-V15-P95 6
MELLON-CA-1990-NATURALISTIC-INQUIRY 6
MEADOWS-AJ-1974-COMMUNICATION-SCI 6
MAY-KO-1967-SCIENCE-V156-P890 6
MARTIN-BR-1991-SCIENTOMETRICS-V20-P333 6
MARSHAKOVA-IV-1988-SISTEMA-TSITIROVANIY 6
LUUKKONEN-T-1992-SCI-TECHNOL-V17-P101 6
LONG-JS-1980-SOC-STUD-SCI-V10-P127 6

LOMNITZ-LA-1987-SOC-STUD-SCI-V17-P115 6
LINE-MB-1978-COLLECTION-MANAGEMEN-V2-P313 6
LIEBOWITZ-SJ-1988-Q-REV-ECON-BUS-V28-P88 6
LEYDESDORFF-L-1988-SCI-PUBL-POLICY-V15-P149 6
LEYDESDORFF-L-1990-SCIENTOMETRICS-V19-P297 6
LAW-J-1988-SCIENTOMETRICS-V14-P251 6
KRONICK-DA-1990-JAMA-J-AM-MED-ASSOC-V263-P1321 6
KOSTOFF-RN-1992-3RD-INT-C-MAN-TECHN 6
KEY-JD-1977-ARCH-PHYSICAL-MED-RE-V58-P136 6
KEEN-PGW-1980-1ST-P-INT-C-INF-SYST-P9 6
JAYARATNE-S-1979-J-ED-SOCIAL-WORK-V15-P72 6
HEINZKILL-R-1980-LIBRARY-Q-V50-P352 6
HAYES-RM-1983-J-EDUC-LIBR-INF-SCI-V23-P151 6
HARTER-SP-1992-J-AM-SOC-INFORM-SCI-V43-P602 6
HAITUN-SD-1982-SCIENTOMETRICS-V4-P5 6
GRILICHES-Z-1979-BELL-J-ECON-V10-P92 6
GOTTLIEB-MS-1981-NEW-ENGL-J-MED-V305-P1425 6
GOLDMAN-RL-1992-JAMA-J-AM-MED-ASSOC-V267-P958 6
GARLAND-K-1987-J-EDUC-LIBR-INF-SCI-V28-P87 6
GARFIELD-E-1980-LIBRARY-Q-V50-P40 6
GARFIELD-E-1978-METRIC-SCI-ADVENT-SC-P179 6
GARFIELD-E-1976-NATURE-V264-P609 6
GARFIELD-E-1982-CURRENT-CONTENT-0301-P5 6
GARFIELD-E-1981-CURRENT-CONTENT-1012-P5 6
GARFIELD-E-1990-ANN-AM-ACAD-POLIT-SS-V511-P10 6
FROST-CO-1979-LIBRARY-Q-V49-P399 6
FOLLY-G-1981-SCIENTOMETRICS-V3-P135 6
EGGHE-L-1987-J-AM-SOC-INFORM-SCI-V38-P288 6
EDWARDS-GW-1984-AM-J-AGR-ECON-V66-P41 6
CULNAN-MJ-1986-MIS-QUART-V10-P289 6
COOK-TD-1979-QUASIEXPERIMENTATION 6
COLE-S-1978-PEER-REV-NATIONAL-SC 6
COLE-S-1983-AM-J-SOCIOL-V89-P111 6
COLE-JR-1972-SCIENCE-V178-P368 6
CHEN-YS-1986-J-AM-SOC-INFORM-SCI-V37-P307 6
CARPENTER-MP-1973-J-AM-SOC-INFORM-SCI-V24-P425 6
CARPENTER-MP-1981-J-AM-SOC-INFORM-SCI-V32-P430 6
CARPENTER-MP-1983-WORLD-PATENT-INFORMA-V5-P180 6
BROOKS-CH-1991-MED-CARE-V29-P755 6
BROOKES-BC-1970-J-DOC-V26-P283 6
BROADUS-RN-1971-INT-SOC-SCI-J-V23-P236 6
BRAUN-T-1991-SCIENTOMETRICS-V20-P359 6
BEYER-JM-1978-SOCIOLOGICAL-Q-V19-P68 6
BASBERG-BL-1987-RES-POLICY-V16-P131 6
BANDURA-A-1986-SOCIAL-F-THOUGHT-ACT 6
BAKER-DR-1990-SOC-WORK-RES-ABSTR-V26-P3 6
ARUNACHALAM-S-1986-J-INFORM-SCI-V12-P105 6
AM-PSYCH-ASS-1987-DIAGN-STAT-MAN-MENT 6
ALLISON-PD-1990-AM-SOCIOL-REV-V55-P469 6
ALBERT-MB-1991-RES-POLICY-V20-P251 6
AJIFERUKE-I-1988-SCIENTOMETRICS-V14-P421 6
<ANON>-1990-JAMA-J-AM-MED-ASSOC-V263-P1317 6

ZUCKERMAN-H-1968-AM-J-SOCIOL-V74-P276 5
YUTHAVONG-Y-1986-SCIENTOMETRICS-V9-P139 5
XHIGNESSE-LV-1967-AM-PSYCHOL-V22-P778 5
WILSON-EO-1975-SOCIOBIOLOGY 5
WHITE-MJ-1977-AM-PSYCHOL-V32-P301 5
WHITE-HD-1989-ANN-REV-INFORMATION-V24-P119 5
WHITE-HD-1981-J-AM-SOC-INFORM-SCI-V32-P163 5
WEINBERG-AM-1963-MINERVA-V1-P159 5
VOGEL-DR-1984-DATA-BASE-V16-P3 5
VLACHY-J-1978-SCIENTOMETRICS-V1-P109 5
VIRGO-JA-1977-LIBR-Q-V47-P415 5
VINKLER-P-1991-SCIENTOMETRICS-V20-P145 5
VINKLER-P-1987-SCIENTOMETRICS-V12-P47 5
VELHO-L-1984-SOC-STUD-SCI-V14-P45 5
VANVIANEN-BG-1990-RES-POLICY-V19-P61 5
VANRAAN-AFJ-1990-NATURE-V347-P626 5
VANRAAN-AFJ-1989-SCIENTOMETRICS-V15-P607 5
TURNER-WA-1988-HDB-QUANTITATIVE-STU-P291 5
TOMER-C-1986-INFORM-PROCESS-MANAG-V22-P251 5
TAUBES-G-1993-SCIENCE-V260-P884 5
SQUIRES-BP-1989-CAN-MED-ASSOC-J-V141-P195 5
SOPER-ME-1976-LIBRARY-Q-V46-P397 5
SMALL-H-1985-SCIENTOMETRICS-V7-P393 5
SINGLETON-A-1976-J-DOC-V32-P258 5
SIEGELMAN-SS-1991-RADIOLOGY-V178-P637 5
SCHAMBER-L-1990-INFORM-PROCESS-MANAG-V26-P755 5
SCARR-S-1978-AM-PSYCHOL-V33-P935 5
SARACEVIC-T-1988-J-AM-SOC-INFORM-SCI-V39-P161 5
RUSHTON-JP-1989-PSYCHOL-B-BRIT-PSYCH-V2-P64 5
ROBIN-ED-1987-CHEST-V91-P252 5
RIP-A-1988-HDB-QUANTITATIVE-STU-P253 5
RICE-RE-1990-SCHOLARLY-COMMUNICAT-P138 5
RESKIN-BF-1979-SOCIOL-EDUC-V52-P129 5
RABKIN-YM-1979-SCIENTOMETRICS-V1-P261 5
PRICE-DJD-1976-J-AM-SOC-INFORM-SCI-V27-P292 5
PORTER-AL-1985-SCIENTOMETRICS-V8-P161 5
PETERS-HPF-1988-INFORMETRICS-87-88-P175 5
PENAVA-Z-1989-J-INFORM-SCI-V15-P71 5
PELZ-DC-1966-SCI-ORG-PRODUCTIVE-C 5
PARDECK-JT-1992-RES-SOCIAL-WORK-PRAC-V2-P487 5
NORTON-GW-1981-AM-J-AGR-ECON-V63-P685 5
NOMA-E-1986-SUBJECT-CLASSIFICATI 5
NEDERHOF-AJ-1988-HDB-QUANTITATIVE-STU-P193 5
NARIN-F-1990-MEASUREMENT-SCI-COOP-V1 5
NARIN-F-1992-RES-POLICY-V21-P237 5
MOTYLEV-VM-1981-INT-FORUM-INFORMATIO-V6-P3 5
MORAVCSIK-MJ-1979-SCIENTOMETRICS-V1-P161 5
MOED-HF-1988-INFORMETRICS-87-88-P133 5
MERTON-RK-1938-OSIRIS-STUDIES-HIST-P362 5
MELTZER-BN-1949-AM-J-SOCIOL-V55-P25 5
MCREYNOLDS-P-1971-AM-PSYCHOL-V26-P400 5
MCLELLAN-MF-1992-ANESTHESIOLOGY-V77-P185 5

MCKIBBON-KA-1990-COMPUT-BIOMED-RES-V23-P583 5
MCCAIN-KW-1989-SCIENTOMETRICS-V17-P127 5
MATSON-JL-1989-AM-PSYCHOL-V44-P737 5
MARTIN-BR-1987-NATURE-V330-P123 5
MARGOLIS-J-1967-SCIENCE-V155-P1213 5
MAHONEY-MJ-1987-J-SOC-BEHAV-PERS-V2-P165 5
MACROBERTS-MH-1987-SCIENTOMETRICS-V12-P293 5
LODAHL-JB-1972-AM-SOCIOL-REV-V37-P57 5
LOCK-S-1990-JAMA-J-AM-MED-ASSOC-V263-P1341 5
LOCK-S-1986-DIFFICULT-BALANCE-ED 5
LINE-MB-1970-J-DOC-V26-P46 5
LINE-MB-1979-J-DOC-V35-P265 5
LINDSEY-D-1992-SOC-SERV-REV-V66-P295 5
LINCOLN-YS-1985-NATURALISTIC-INQUIRY 5
LEYDESDORFF-L-1991-SOC-NETWORKS-V13-P301 5
LEYDESDORFF-L-1991-SCIENTOMETRICS-V20-P363 5
LENK-P-1983-J-AM-SOC-INFORM-SCI-V34-P115 5
LAWANI-SM-1983-J-AM-SOC-INFORM-SCI-V34-P59 5
LATOUR-B-1987-SCI-ACTION 5
LATOUR-B-1987-SCI-ACTION-FOLLOW-SC 5
LANCASTER-FW-1986-SCIENTOMETRICS-V10-P243 5
LABAND-DN-1985-SOUTHERN-ECON-J-V52-P216 5
KOSTOFF-RN-1991-22ND-P-ANN-PITTSB-C 5
KOSTOFF-RN-1988-IEEE-T-ENG-MANAGEMEN-V35 5
KING-J-1987-J-INFORMATION-SCI-V13 5
IRVINE-J-1985-SOC-STUD-SCI-V15-P293 5
IRVINE-J-1983-SOC-STUD-SCI-V13-P49 5
HICKS-D-1986-R-D-MANAGE-V16-P211 5
HELMREICH-RL-1980-J-PERS-SOC-PSYCHOL-V39-P896 5
HE-CP-1986-INFORM-PROCESS-MANAG-V22-P405 5
HARNAD-S-1982-PEER-COMMENTARY-PEER 5
HAITUN-SD-1982-SCIENTOMETRICS-V4-P89 5
GRILICHES-Z-1957-ECONOMETRICA-V25-P501 5
GRAVES-PE-1982-AM-ECON-REV-V72-P1131 5
GILLETT-R-1989-HIGH-EDUC-Q-V43-P20 5
GILLETT-R-1987-B-BRIT-PSYCHOL-SOC-V40-P42 5
GARVEY-WD-1979-COMMUNICATION-ESSENC 5
GARFIELD-E-1990-CURRENT-CONTENT-0806-P5 5
GARFIELD-E-1990-CURRENT-CONTENT-0813-P5 5
GARFIELD-E-1992-SCI-PUBL-POLICY-V19-P321 5
GARFIELD-E-1970-NATURE-V227-P669 5
GARFIELD-E-1964-SCIENCE-V144-P649 5
GARFIELD-E-1992-THEORETICAL-MED-V13-P117 5
FRIEDMAN-LM-1981-STANFORD-LAW-REV-V33-P773 5
FLEISS-JL-1981-STATISTICAL-METHODS 5
FEEHAN-PE-1987-LIBR-INFORM-SCI-RES-V9-P173 5
FARHOOMAND-A-1987-DATA-BASE-V18-P48 5
FAIRTHORNE-RA-1969-J-DOC-V25-P319 5
EVERETT-JE-1991-J-AM-SOC-INFORM-SCI-V42-P405 5
ENGLER-RL-1987-NEW-ENGL-J-MED-V317-P1383 5
EICHORN-P-1987-AM-J-PUBLIC-HEALTH-V77-P1011 5
EGGHE-L-1990-INTRO-INFORMETRICS-Q 5

EGGHE-L-1992-INFORM-PROCESS-MANAG-V28-P201 5
EGGHE-L-1990-INFORMETRICS-89-90-P97 5
DREW-DE-1981-RES-HIGH-EDUC-V14-P305 5
DHAWAN-SM-1980-J-DOC-V36-P24 5
DAVIS-CH-1989-SCIENTOMETRICS-V15-P215 5
COLE-JR-1979-FAIR-SCI-WOMEN-SCI-C 5
COLE-FJ-1917-SCI-PROGR-V11-P578 5
COHEN-J-1988-STATISTICAL-POWER-AN 5
CHEUNG-KFM-1990-SOC-WORK-RES-ABSTR-V26-P23 5
CHEN-YS-1987-SCIENTOMETRICS-V11-P183 5